EMD

Operating Manual

MILITARY ROAD SWITCHER MODEL MRS-1

GENERAL MOTORS LOCOMOTIVES

ELECTRO-MOTIVE DIVISION
GENERAL MOTORS CORPORATION • LA GRANGE, ILLINOIS, U. S. A.

OPERATING AND MAINTENANCE INSTRUCTION MANUALS

FOR

GENERAL MOTORS 1600 HP MODEL MRS-1 LOCOMOTIVE

LOCOMOTIVE, DIESEL ELECTRIC
56-1/2, 60, 63, and 66 Inch Gauges
120-Ton, 0-6-6-0 Wheel, Single Power Plant
(Domestic And Foreign Service)

FOR

UNITED STATES ARMY TRANSPORTATION CORPS

Military Specification MIL-L-10602 TC
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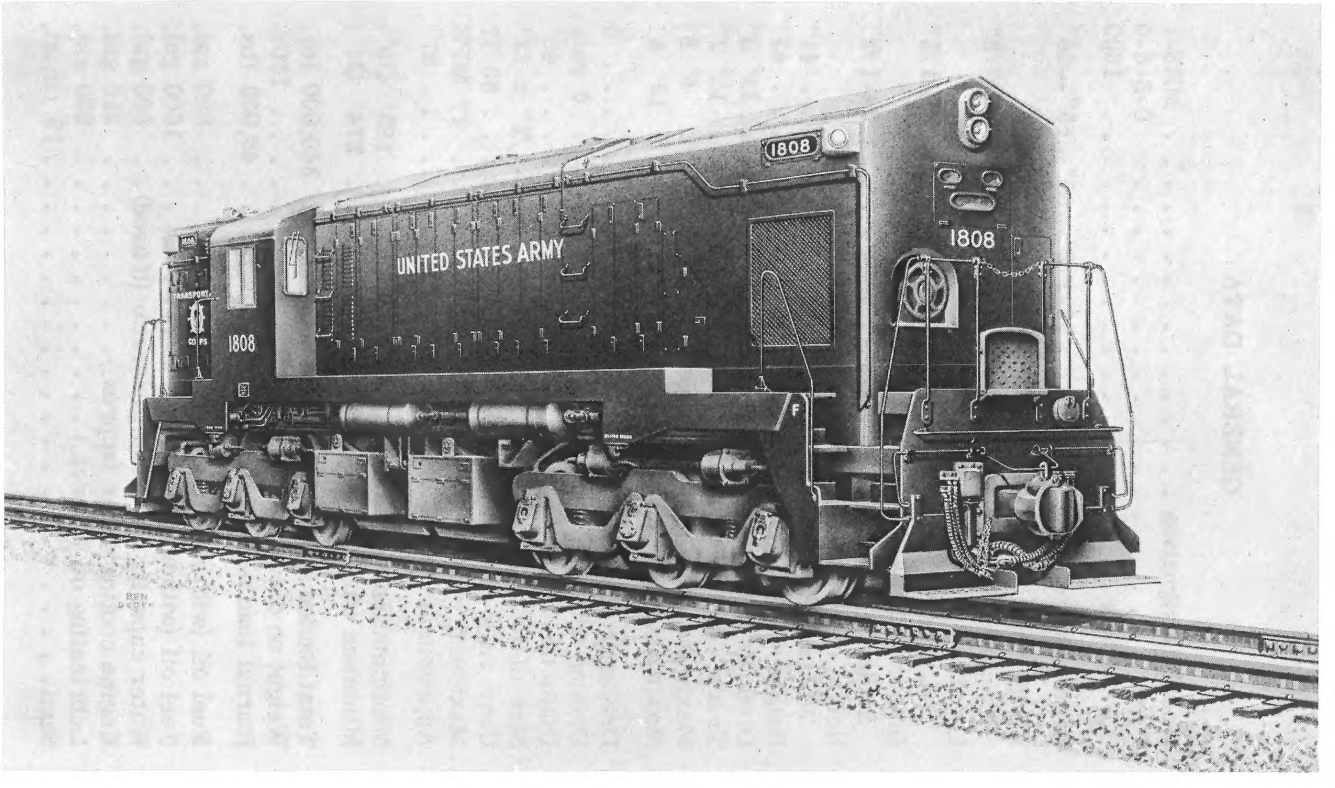
INTRODUCTION

The purpose of this manual is to acquaint operating and maintenance men with the overall operation of the locomotive, as well as the functions of the more important pieces of equipment. The operating manual covers the Military Road Switching Locomotive, Model MRS-1, designed and built by the Electro-Motive Division of General Motors Corporation, La Grange, Illinois, U.S.A.

The manual is divided into ten sections, listed below (the articles in each section are listed completely in the table of contents):

Section 1 - General Description
Section 2 - Operation
Section 3 - Electrical Equipment
Section 4 - Cooling System
Section 5 - Lube Oil System
Section 6 - Fuel Oil System
Section 7 - Air System
Section 8 - Cold Weather Starting
Section 9 - Steam Generator
Section 10 - Locomotive Trouble Shooting
Appendix

The various articles in each section are numbered consecutively for ready reference, as is each page of a Section. Articles and pages are numbered in the 100 series type of numbering; a page in the 300's is in Section 3, as is any article numbered in the 300's.


1808
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GENERAL DATA

Model Designation	MRS-1
Type	0-6-6-0
Horsepower	1600
Track Gauge	56-1/2"—60"—63"—66"
Length over coupler pulling faces - Standard AAR Couplers	57′ 5"
Length over coupler pulling faces - Willison Auto. Couplers	57′ 8-1/2"
Height of center of coupler above rail - Standard AAR	34-1/2"
Height of center of coupler above rail - Willison Automatic	41"
Height of buffer center above rail	42"
Distance between bolster centers	31′ 0"
Truck - rigid wheelbase	13′ 2"
Maximum width of locomotive	9′ 8"
Maximum height above rail	13′ 6"
Driving motors	6
Driving wheels	6 pair
Diameter of wheels	40"
Size of journals	6-1/2" x 12"
Gear ratio	60/17
Maximum permissible speed	77 MPH
Approximate height of center of gravity	57"
Minimum curve radius (light engine)	193′ (30°)
Minimum curve radius (coupled to train)	274′ (21°)
Total loaded weight on drivers (approx.)	240,000 lbs.
Weight on drivers	100%
Journal load per driving axle (approx.)	40,000 lbs.
Fuel oil (with steam generator)	800 gal.
Fuel oil (without steam generator)	1600 gal.
Water capacity for steam generator (if used)	800 gal.
Engine cooling water (approx.)	210 gal.
Lubricating oil (approx.)	200 gal.
Sand	18 cu. ft.

TABLE OF CONTENTS

	Page
SECTION 1 - GENERAL DESCRIPTION	100
General	100
Diesel Engine	100
Main Generator And Alternator	101
Traction Motors	101
Auxiliary Equipment	102
Engineman's Controls	102
Engineman's Control Station	102
Throttle Lever	104
Reverse Lever	104
Transition Forestalling Switch	105
Control Panel	106
Black-Out Switch	106
Classification Lights	106
Headlight Operation	107
Number Lights	108
Load Indicating Meter	108
Air Gauges	108
Ground Relay Light	108
Wheel Slip Indicator	108
PC Switch And PCS Open Light	109
Electrical Cabinet	109
Instrument Panel	110
Brake Equipment	111
Air Brakes - General	111
Independent Brake Valve	111
Double Heading Cock	112
Engine Room	112
Engine Room - General	112
Engine Governor	113
Engine Overspeed Trip	114
Layshaft Manual Control Lever	114

Cylinder Test Valves 115
Air Box Drains 116
Load Regulator 116
Engine Room Ventilation 116
Engine Radiator Cooling Fans 117
Traction Motor Blowers 117
Air Compressor 118
Standby Heaters 118

Miscellaneous Equipment 119
Hand Brake 119
Horn Valve 119
Locomotive Bell 120
Sanding Valve 120
Cab Heaters 120
Speed Recorder 120
Windshield Wipers 120
Air Reservoirs 121
Fuel Tank 121
Water Tank 121
Storage Battery 121
Sand Boxes 122
Fire Extinguishers 122
Trucks 122
Rail Guard 123
Journal Boxes 123
Couplers 123
Steam Generator 123

SECTION 2 - OPERATION 200

When Boarding The Locomotive 200

Starting And Stopping Engine 201
Precautions Before Starting Engine 201
To Start Engine 203
Placing An Engine On The Line 204
To Stop Engine 204
Securing Locomotive For Layover 204

Handling Locomotive 205
Precautions Before Moving Locomotive 205
Handling Light Locomotives 205
Coupling To Train And Pumping Up Air 206
Starting A Train 206

Braking 208
Air Braking With Power 208

Miscellaneous Operating Instructions 210
Wheel Slip Indication 210
Indication Of A Pair Of Wheels Sliding 210
Ground Relay Action 211
Motor Cutout Switches 211
Operating Over Railroad Crossings 212
Running Through Water 212
Double Heading 212
Isolating An Engine 213
Towing Locomotive 213
Recovery Of Brake After Penalty Application 214
Freezing Weather Precautions 215
Splitting And Joining Units 215
Multiple Unit Operation 216
Changing Operating Cabs 216

SECTION 3 - ELECTRICAL EQUIPMENT 300

General Electrical Scheme 300
Main Generator 301
Alternator 302
Traction Motors 303
Reverser 303
Transition 305
Transition Forestalling Switch 306
Load Regulator 307
Battery Field Contactor And Fuse 308
Main Battery Switch 309
Battery Ammeter 309
Reverse Current Relay 311

Battery Charging Contactor 311
Battery Charging Fuse 311
Auxiliary Generator Field Switch 311
Voltage Regulator 311
Engine Speed Control 312
Engine Relay (ER) 312
Wheel Slip Control 315
Isolation Switch 317
Ground Relay (GR) 317
No AC Voltage Relay (NVR) 318

SECTION 4 - COOLING SYSTEM 400

Description Of The Cooling System 400
Operating Water Level 401

SECTION 5 - LUBRICATING OIL SYSTEM 500

Oil Level 500
Adding Oil To System 500
Oil Pressure 500

SECTION 6 - FUEL OIL SYSTEM 600

Description Of Fuel Flow 600
Filling Fuel Tank 601
Emergency Fuel Cutoff Valve 601

SECTION 7 - AIR SYSTEM 700

Air Compressor 700
Compressor Control 702
Air Compressor Manual Unloader Valve 704
Draining Of Air System 704

SECTION 8 - COLD WEATHER STARTING 800

General 800
Operation Of The Winterization System 800
Description Of Heater 805

Heater Operating Instructions 807
Running Attention 809
Trouble Shooting 809
Maintenance - Quarterly Inspection - 300 Hours 810

SECTION 9 - STEAM GENERATOR 900

Introduction 900
Description 900
Before Starting 902
To Fill 903
To Start 904
Running Attention 905
To Shut Down Steam Generator 905
Freezing Weather Precautions 907
Trouble Shooting 908
Remote Control Equipment 912
Items To Report 913
Operation Chart 915
Trouble Shooting Chart 917

SECTION 10 - LOCOMOTIVE TROUBLE - SHOOTING 1000

General 1000
If Alarm Bells Ring 1002
Red 1002
Green 1002
Purple 1003
Yellow 1005
White 1006
Engine Goes To Idle 1006
Engine Stops 1006
How To Start Engine 1007
The Engine Does Not Rotate When "Start" Button Is Pressed 1008
The Engine Rotates But Does Not Start When "Start" Button Is Pressed 1009
The Engine Does Not Speed Up When Throttle Is Opened 1009

Engine Speed Picks Up But Locomotive Does Not Move When Throttle Is Opened 1010
Battery Ammeter Shows Continual Discharge 1010
Locomotive Fails To Make Forward Transition 1010
PC Switch 1011
Ground Relay 1013
Starting Contactors 1013
Engine Overspeed Trip 1014
Lube Oil Push Button On Governor 1014
Fuel Cutoff Valves 1015
Fuel Flow 1015
Engine Speed And Fuel Indicators 1016
Control Air Pressure 1016
Compressor Control 1016
Cylinder Test Valves 1017
Tying Up Locomotive 1018

APPENDIX Chart

MRS-1 Locomotive Outline 1
Legend Of Electrical Equipment 2
Electrical Symbols 3
Schematic Wiring Diagram 4
Winterization System Schematic 5

SECTION 1

GENERAL DESCRIPTION

100 GENERAL The 120-ton military road switching locomotive known as the Model MRS-1 has been designed to operate in extreme hot or cold weather on any of 4 different gauges of track. This locomotive is powered with a 1600 horsepower Diesel engine. The locomotive type is designated as a 0-6-6-0, all wheels are drivers, and each axle is driven by a separate traction motor.

The MRS-1 locomotive is arranged to operate either as an individual unit or in multiple with one or more units coupled together; all of which are then controlled from one operating cab.

The front end of the locomotive is at the long hood end.

101 DIESEL ENGINE The main generator and auxiliaries of the locomotive are driven by a 16-cylinder, V-type, 2 cycle, Model 567B Diesel engine. The cylinders have an 8-1/2" bore and a 10" stroke. The two banks of the engine are arranged with respect to each other at an angle of 45°.

The engine is started by temporarily using the direct coupled main generator as a starting motor; current from the storage battery "motors" the main generator to rotate the engine.

NOTE: In this Manual, the word "engine" refers specifically to the Diesel engine; the word locomotive will refer to one or more units coupled together.

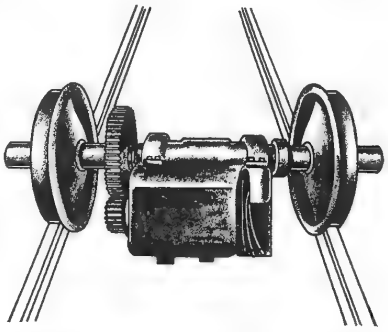
At full load the engine will consume approximately 95 gallons of fuel per hour; at idle the fuel consumption is approximately 3.5 gallons per hour. In road oper-

ation the fuel consumption will average approximately 1.8 gallons per MGTM (or 50 GPH).

102 MAIN GENERATOR AND ALTERNATOR Directly connected to the engine flywheel through a flexible coupling is an assembly which can be said to be two generators built into one; this is the D12 main generator and the D14 alternator assembly.

The main generator is a constant KW generator which produces direct current at a nominal 600 volts to supply the power to the six traction motors. The alternator is a 3-phase, 149 volt, 80 KW alternating current generator whose only purpose is to supply the power to the AC traction motor blowers and the engine water cooling fans. The two electrically separate sections (main generator and alternator) are mounted on the same shaft.

103 TRACTION MOTORS There are three heavy duty, series wound, DC traction motors mounted in each truck. Each axle is driven by a separate traction motor. On this locomotive a 17-tooth traction motor pinion gear meshes with a 60-tooth axle gear to transmit the power from the traction motor to the wheels, as illustrated in Fig. 1-1. The motors are connected to the main generator in what is called a permanent series-parallel connection, Figs. 3-3 and 3-4. Automatic motor shunting is provided for the traction motor fields when the locomotive speed reaches approximately 23 MPH in the full throttle position.



Wheels And Motor Assembly
Fig. 1-1

104 AUXILIARY EQUIPMENT Auxiliary equipment on this locomotive is driven entirely by direct drive from the Diesel engine or by separate electric motors.

An auxiliary generator is mounted on top of the main generator and is direct driven through flexible couplings from the rear gear train of the engine. The auxiliary generator produces direct current to charge the storage battery and supply the low voltage circuits for lighting, control, generator field excitation, fuel pump operation, etc. An automatic voltage regulator keeps the output voltage of the auxiliary generator at a constant 74 volts.

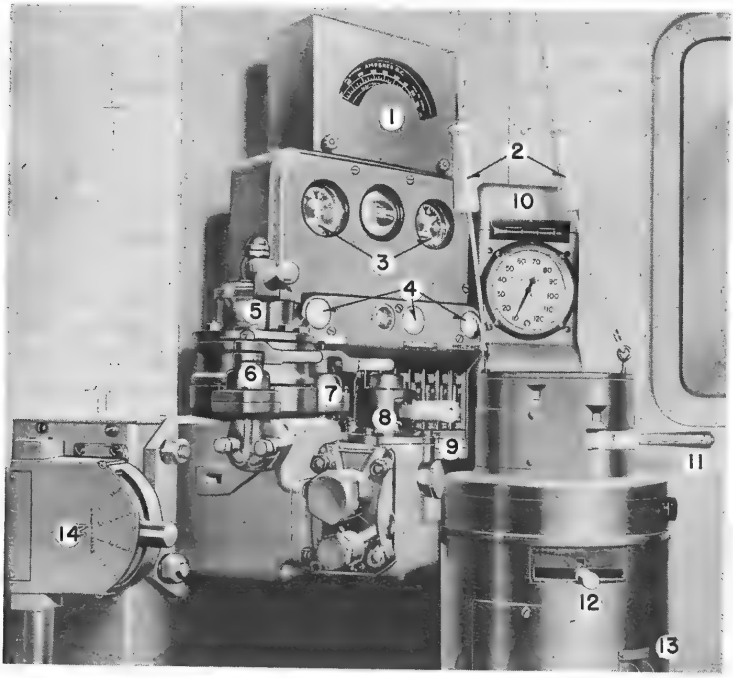
A 5 HP electric (AC) driven blower is provided for each traction motor. These blowers are mounted on the floor of the carbody and supply cooling air through flexible ducts to the traction motors.

Four 9 HP electric (AC) driven cooling fans mounted under the hood at the front of the locomotive supply the air for the engine water cooling radiators. These fans are thermostatically controlled, but provision is also made to manually turn on or off these fans with switches (see Art. 400).

Mounted in the front portion of the engine room is a 3-cylinder, two stage, air compressor, rated at 225 CFM at 800 RPM, which is driven through a flexible coupling and an extension shaft from the front end of the engine.

ENGINEMAN'S CONTROLS

105 ENGINEMAN'S CONTROL STATION The engineman's controls, Fig. 1-2, are located to the left of the engineer's seat. These include the controller, air brake stand, control panel, load indicating meter, speed recorder (if used), and headlight dimming switch.



1. Load Indicating Meter
2. Horn Pull Cords
3. Air Gauges
4. Indicator Lights
5. Automatic Brake Valve
6. Sanding Valve
7. Bell Ringer Valve
8. Independent Brake Valve
9. Control Switches
10. Speed Recorder (If Used)
11. Throttle Lever
12. Reverse Lever
13. Forestalling Switch
14. Headlight Dimming Switch

Engineman's Control
Fig. 1-2

Two levers and two brake valve handles control the entire operation of the locomotive; these are the throttle and reverse levers which are mounted in the controller, and the independent and automatic brake valve handles, which are mounted on the brake stand.

106 THROTTLE LEVER This lever is mounted in the controller to control the speed of the engine and consequently the power delivered to the traction motors. The throttle can be moved only when the reverse lever is inserted in the controller, and has ten positions: Stop, Idle and Running Speeds 1 to 8. The position of the throttle is shown in the illuminated indicator above the lever. The Stop position can be obtained with any position of the reverse lever by depressing the emergency stop button on the end of the throttle lever and pushing this lever one step beyond the Idle position; this will stop the engine if the isolation switch is in the Run position. The Idle position is as far forward as the throttle lever can be moved without depressing the emergency stop button. The throttle can be opened or closed fully in one movement but should normally be done a notch at a time.

107 REVERSE LEVER The reverse lever, mounted in controller, has three positions: Forward, Neutral and Reverse. Direction of the locomotive is controlled by movement of this lever to the forward or reverse position. The reverse lever must not be moved except when the locomotive is standing still. The reverse lever can only be moved when the throttle lever is in Idle. Leaving the reverse lever in Neutral will prevent the development of power when the throttle is opened.

The operating controls can be locked by removing the reverse lever from the controller. The reverse lever can only be removed from the controller when in the Neutral (center) position, provided the throttle is in the Idle position.

108 TRANSITION FORESTALLING SWITCH This switch is located on the side of the controller, Fig. 1-2. With the switch placed in the SERIES position the motor connections will remain as shown in Figures 3-3 and 3-4, regardless of locomotive speed. With the switch in the AUTOMATIC position, motor shunting will automatically take place at approximately 23 mph, with the throttle in Run 8.

Control Panel
Fig. 1-3

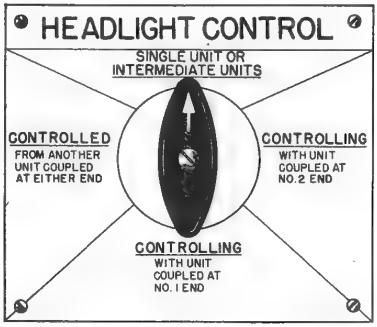
109 CONTROL PANEL The control panel located between the controller and brake stands contains switches, gauges and light indicators for use in the proper operation of the locomotive, Fig. 1-3. Gauge lights are provided to illuminate the panel.

The engineman's control switches are mounted in the lower portion of the control panel. These switches are in reality circuit breakers and therefore take the place of fuses in the circuits. In case of an overload the affected circuit breaker will "kick out," moving the switch lever to the mid-position, to give a visual indication of the circuit affected. For normal operation the Control, Fuel Pump and Generator Field switches must be ON.

110 BLACK-OUT SWITCH A black-out light switch is located in the control panel, Fig. 1-3. When turned ON (up) this switch causes all lights in the locomotive to be extinguished, except the headlights, which may be turned OFF separately.

111 CLASSIFICATION LIGHTS The front and rear classification lights are controlled by switches on the control switch panel. Four permanently fixed clear bull's-eye lenses are provided, two on the front of the locomotive hood and two on the rear of the locomotive. Inside the hood and behind each bull's-eye, a small compartment contains the classification light bulb and colored lenses. Red and green lenses are provided in each compartment which can be moved into a position between the bulb and the bull's-eye. To accomplish this a locking pin is removed, the desired lens swung into place and the locking pin replaced. The colored lenses are accessible from the outside of the hood since the classification lights are mounted on a hinged portion of the hood. When both red and green lenses are out of position the permanent bull's-eye lens will show a white light, thus making three colors available.

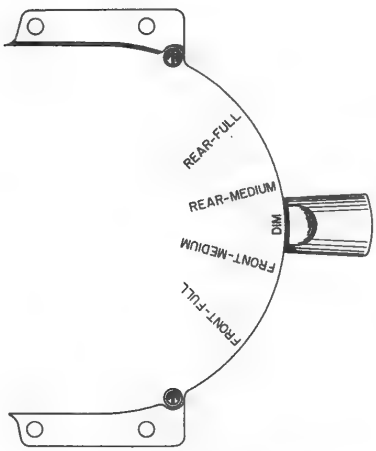
112 HEADLIGHT OPERATION At the front and rear end of the locomotive, the twin sealed beam headlights are connected in parallel; therefore if one bulb "burns out," the other will remain lit. The headlights, front and rear, are controlled by three different switches; (1) the front and rear headlight ON-OFF switches located in the control switch panel, Fig. 1-3, (2) the remote headlight switch located in front of the engineman, below the control panel, Fig. 1-4, and (3) the three point dimming control switch located to the left of the engineman, Fig. 1-5.



Remote Headlight Switch
Fig. 1-4

The front and rear headlights may both be ON at the same time but the dimming control switch makes it impossible to have more than one headlight on Medium or Bright at a time. As seen in Fig. 1-5 the dimming control switch has Dim, Medium, and Bright positions.

The instructions for operating the remote headlight switch are given on the face of the switch box; this switch must be properly set for satisfactory operation of headlights. The Black-Out switch (Art. 110) does not have any control of the headlights.



Headlight Dimming Switch
Fig. 1-5

113 NUMBER LIGHTS The front and rear number lights are controlled by switches on the control switch panel. The number lights are located in the hood beside the classification lights on either end of the locomotive.

114 LOAD INDICATING METER This meter is a guide to the load and pulling force of the locomotive, Fig. 1-6. The meter is connected in series with the No. 5 and 6 motors. The dial of the meter is graduated into amperes, from 0 at the left to 1500 amperes at the extreme right of the scale.

115 AIR GAUGES These are standard gauges which are labeled as to their function. These gauges indicate main reservoir, brake cylinder, brake pipe, and equalizing reservoir air pressures.

116 GROUND RELAY LIGHT When the ground relay "trips" this white light will be lit and the alarm bell will ring, see Art. 213.

117 WHEEL SLIP INDICATOR This is a white light mounted on the control panel. The flashing

Load Indicating Meter
Fig. 1-6

of this light indicates that a pair or more of wheels are slipping. Although the power is automatically reduced during slipping and automatically reapplied when the slipping has stopped, the throttle should be reduced one notch at any time that the wheel slip light flashes repeatedly, applying sand as needed. When rail conditions improve the throttle may be returned to its original position.

118 PC SWITCH AND PCS OPEN LIGHT The PC, or pneumatic control switch is often called the power cutoff switch. This is a normally closed electric switch that is operated by the air brake system. During a "penalty" or emergency air brake application this switch opens and automatically reduces the power output of the engine. When tripped open the PC switch causes the engine relay (ER) to be de-energized which immediately reduces the engine to Run 1 and shuts off the fuel pump (in multiple unit operation ALL engines will be reduced to Run 1 and ALL fuel pumps stopped). If the throttle happens to be in the 5th or 6th notch when the PC switch trips, the engine will stop, unless the throttle is immediately moved to some other throttle position. A white PC Switch Open indicating light, mounted in the control panel, will be lit whenever the PC switch is tripped.

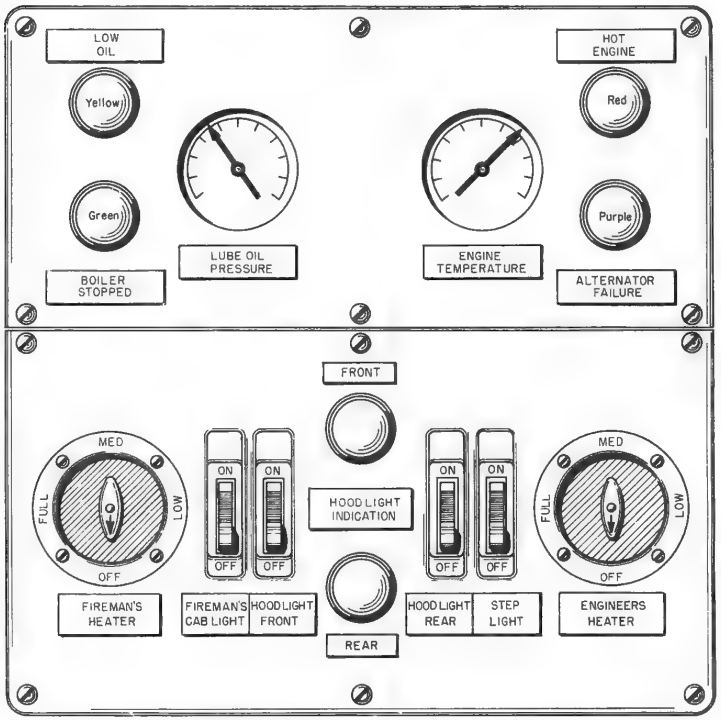
The PC switch automatically resets itself provided that (1) the throttle is returned to IDLE, and (2) control of the brake is recovered (see Art. 220 for method of recovering control of the brake). When this has been accomplished the PC Switch Open indicating light will turn off.

119 ELECTRICAL CABINET The electrical cabinet is located behind doors in the rear cab partition. This cabinet contains the various high and low voltage switches, contactors, relays, and other equipment necessary for the electrical and electro-pneumatic

control of the locomotive. A detailed discussion of the various items in this cabinet is given in Section 3 of this Manual.

The Control, Lights and Main Battery knife switches, mounted on a panel in the electrical cabinet, should all be closed for normal operation. The five circuit breaker switches on that panel should also be ON, for normal operation.

120 INSTRUMENT PANEL The instrument panel, Fig. 1-7, is located above the door in the front cab partition. This panel contains the lubricating oil



Instrument Panel
Fig. 1-7

pressure gauge, the engine water temperature gauge, four alarm indicating lights, the two cab heater switches, the front and rear hood light switches (and light indicators), the fireman's cab light switch and the step light switch.

The front and rear hood (engine room) lights are provided with light indicators on the instrument panel which will be lit when their respective switches are in the ON position. The utility receptacles in the engine rooms are energized only when the proper hood light switch is ON.

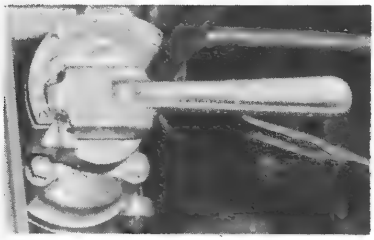
The gauge light for the instrument panel is controlled by the gauge light switch on the control panel, Fig. 1-3.

BRAKE EQUIPMENT

121 AIR BRAKES - GENERAL The MRS-1 locomotive is equipped with 6BL air brake equipment manufactured by the New York Air Brake Company. For detailed information on the operation and maintenance of this equipment, refer to the manufacturer's Instruction Pamphlet No. 62.

The equipment and operation of this brake is identical to that widely used on American railroads.

122 INDEPENDENT BRAKE VALVE The independent brake valve handle has two positions, release and full application, with the application zone between the two positions. The brake valve is of the self-lapping type which automatically laps off the flow of air and maintains brake cylinder pressure, when the application pressure reaches the value corresponding to the position of the brake valve handle in the application zone. Locomotive brakes may be released after an automatic application by depressing the independent brake valve handle in the release position.



Double Heading Cock
Fig. 1-8

123 DOUBLE HEADING COCK The three position double heading cock is located beneath a small trap door in the floor of cab, Fig. 1-8. The three positions which are marked in raised letters on the cock body are LEAD, TRL'G, and DEAD.

ENGINE ROOM

124 ENGINE ROOM - GENERAL The entire area forward of the cab and enclosed under the hood is called the engine room. The engine room is partitioned into three separate sections: (1) the main generator compartment, (2) the engine compartment, and (3) the radiator cooling fan compartment. Each of the three compartments of the engineroom may be entered through doors located on the sides of the hood. As will be described in Art. 131, louvers, shutters, a damper, and grilles are provided in the hood to enable air to be drawn into or through the various compartments as desired.

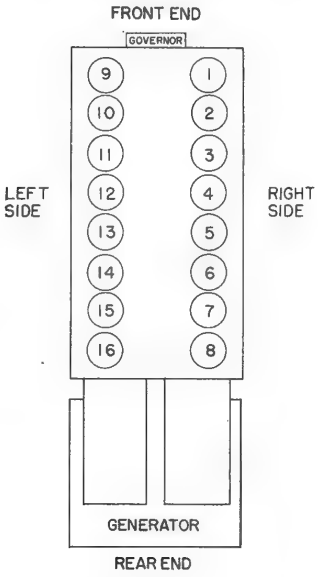


Fig. 1-9

The two ends of the 1600 HP engine are designated FRONT and REAR, as shown in Fig. 1-9. This figure will serve to identify the cylinder locations, ends and sides of the engine. The governor, water pumps and lubricating oil pumps are on

the FRONT END. The engine blowers, oil separator and generator are on the REAR end.

The engine is placed so that its front end is toward the front end of the locomotive when the locomotive is operating in its normally forward direction.

125 ENGINE GOVERNOR A governor, mounted on the front end of the engine performs the function of controlling the speed of the Diesel engine (from 275 RPM at Idle to 800 RPM at full throttle) as directed by the position of the throttle at the control stand. The "orders" of the throttle are transmitted to the governor through electrical circuits. The governor is mechanically connected through a linkage to the injector control shafts on each bank of the engine. Thus, by regulating the position of the injector racks, and consequently the fuel injected to each cylinder, the governor is able to perform its job of seeing that the engine rotates at the speed ordered by the throttle, regardless of how much or how little fuel is needed. A device called the load regulator, described in Art. 130, acts to cause the governor to allow injection of no more or no less fuel to each cylinder than the proper amount for each speed setting.

A low oil pressure device built into the governor protects the engine in case of low oil pressure or high vacuum on the suction side of the pressure lubricating oil pump. In the event of such lubricating oil trouble, the governor will immediately stop the engine. The alarm bell will sound throughout the locomotive and the yellow LOW OIL signal light will be lit in the unit affected. The purple ALTERNATOR FAILURE signal light will also be lit, when the engine stops.

When the governor low oil pressure device stops the engine, a push button protrudes from the front of the governor housing and exposes a red band around

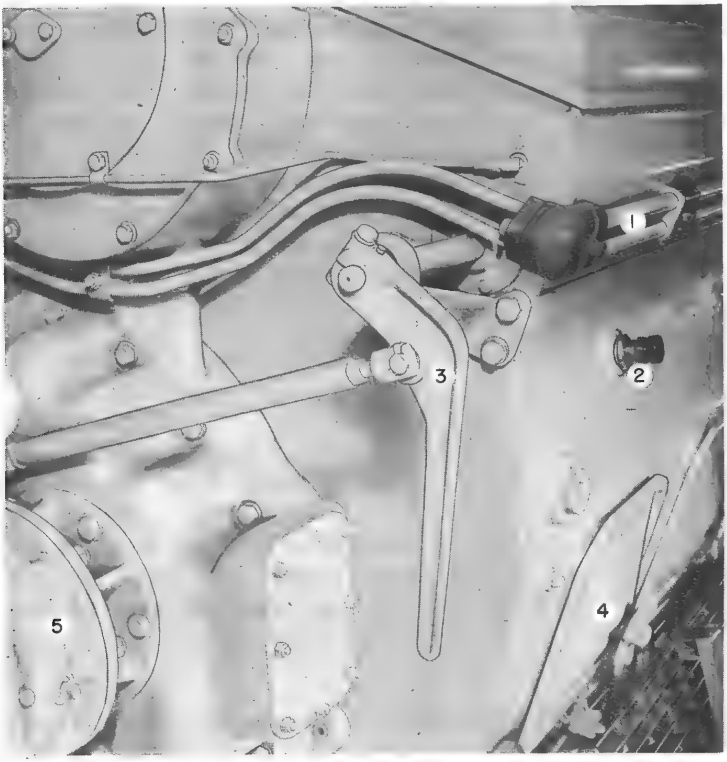
the shaft of button. This push button must be pressed IN to extinguish the Low Oil alarm light, and the isolation switch moved to the START position to extinguish the Alternator Failure alarm light; both actions are required to stop the alarm bell. The low oil push button will not trip if the engine is stopped by any means other than oil trouble.

If an engine is stopped by governor safety control action, the push button must be reset before the engine can be started. When the engine is started and run at idling speed, the governor will stop the engine after approximately forty seconds, if the condition still exists which caused the original shutdown. This time delay is provided to allow a check to determine the cause of the shutdown. The engine should not be repeatedly started if the governor persists in shutting the engine down. If an attempt is made to run the engine above idling speed during the delay period, the governor will stop the engine at once if the oil pressure is low or the oil pump suction high.

126 ENGINE OVERSPEED TRIP If the engine speed should exceed approximately 910 RPM, an engine overspeed device located in the front end of the engine will trip and bring the engine to a stop. Once this overspeed device is tripped, it must be reset manually (by pulling the lever counter-clockwise until it latches) before the engine can again be started, see Fig. 10-21.

127 LAYSHAFT MANUAL CONTROL LEVER The layshaft manual control lever is attached to the end of the injector control shaft, at the left front corner of the engine, Fig. 1-10. This lever may be used to manually shut down the engine, to keep the engine from firing, or to facilitate the starting of a cold engine.

128 CYLINDER TEST VALVES These valves are located on the outside of the engine at each cylinder, Fig. 1-10, and when opened to atmosphere relieve the compression of the cylinders. The cylinder test valves are generally used to make a test, prior to starting the engine to see whether water has possibly seeped into the cylinder. This is done by opening the cylinder test valves approximately three turns and then jacking the engine over to see if water is discharged



1. Fuel Oil Manifold
2. Cylinder Test Valve
3. Engine Layshaft
4. Air Box Hand Hole Cover
5. Water Pump (Left Bank)

Engine Room — Left Side
Fig. 1-10

from any of the valves. DO NOT STAND IN FRONT OF OPENED CYLINDER TEST VALVES WHEN THE ENGINE IS BEING ROTATED.

129 AIR BOX DRAINS The engine has two air box drain tanks incorporated in the engine oil pan near the generator end, one on each side. These tanks have a valve in the drain line so that the tanks may be drained when the locomotive is standing still; this prevents sludge and oil from the tank being carried onto the running gear. Any excessive amount of sludge or oil observed to be draining from this drain should be reported to the maintenance force.

130 LOAD REGULATOR The load regulator is located above the oil filter and is mounted on the equipment rack. In reality, the load regulator is merely an automatically operated rheostat connected in series with the battery field windings of the main generator. A vane motor operated by engine lubricating oil pressure, as directed by the load regulator pilot valve and a dump valve (ORS), which are located in the engine governor, causes movement of the load regulator.

The function of the load regulator is to automatically vary the battery field strength in the main generator, thereby maintaining a power output, corresponding to a definite rate of fuel consumption, as determined by the position of the throttle, see Art. 307 for further details.

131 ENGINE ROOM VENTILATION The engine room is partitioned into three separate sections. Air is admitted into the main generator compartment through louvers which are contained in the doors of the hood on either side of the compartment. Manually operated shutters located in the hood near the engine blowers are to be opened in mild or hot weather to admit air into the engine compartment. The partition

between the engine and cooling fan compartments contains a bolted sliding damper which is to be opened in mild or warm weather. During severe cold weather the manually operated shutters are to be closed as is the sliding damper in the forward partition. Thus, during winter operation the engine and #3 traction motor blower and air compressor will receive air from the main generator compartment via the main generator blower.

The air to the cooling fan compartment is always open through grille work on either side of the hood. The #1 and #2 traction motor blowers draw air from this compartment to cool the #1 and #2 traction motors.

132 ENGINE RADIATOR COOLING FANS Four 9 HP (AC) electric driven cooling fans are located below the hood and engine radiators in the front end of the locomotive. The fans are arranged in two banks and each fan forces air up through two sections of the radiator. Automatic shutters, located in the hood above the fans, open when the first cooling fan is turned ON. The fans are numbered from front to rear, beginning at the front right hand corner; each fan is thermostatically controlled, but switches are provided to enable manual operation of the fans (i.e. each fan may be individually turned ON or OFF in case the thermostatic switches should fail). The manual switches are located behind a glass door on the front of the hood, Fig. 4-1. The thermostatic switches are set to cause a fan operating sequence of 1-3-2-4 corresponding to temperatures of 165°, 168°, 171° and 180°, respectively.

133 TRACTION MOTOR BLOWERS Each of the six traction motors is provided with a 5 HP (AC) electric driven blower which forces cooling air through the traction motor. The blowers are mounted on the floor of the carbody; flexible ducts connect each blower discharge to its respective traction motor. Since the

blowers are powered by the alternator, the speed of the blower varies with the generated frequency of the alternator which is affected by the engine speed. As the blowers must be operating whenever the engine is running, they are permanently connected to the alternator. To further assure that cooling air is supplied to the traction motors, a No Voltage Relay (NVR) is connected to the alternator output to cause an alarm whenever power is unavailable for the blowers.

134 AIR COMPRESSOR A three cylinder, two stage air compressor capable of delivering 225 CFM at 800 RPM is direct-driven through a flexible coupling and an extension shaft from the front end of the engine.

135 STANDBY HEATERS Two standby heaters are included on the locomotive for allowing the engine cooling, fuel, and lubricating oil systems to be warmed when the locomotive is shut down in cold weather. The heaters are used to permit starting of the engine in severe cold weather following a layover period in which the engines have been shut down.

One standby heater is arranged so that it may heat and circulate the water (possibly containing anti-freeze) in the engine cooling system.

The second standby heater is arranged so that is heats and circulates an anti-freeze solution through heating pipes that are immersed in the fuel tank, lubricating oil sump, and are also lagged to the fuel lines leading to the sintered bronze filter in the engine. See Section 8 for details.

The hot exhaust gases of the heaters are conducted to the battery boxes on either side of the locomotive; i.e. the engine cooling system heater discharges its exhaust gases into the battery box on the left side of

the locomotive, before the gases are exhausted to the atmosphere. The heater that causes the fuel and lube oil system to be warmed discharges its gases to the battery box on the right side of the locomotive, prior to being exhausted to atmosphere. Cold weather operation of these heaters is outlined in Section 8.

MISCELLANEOUS EQUIPMENT

136 HAND BRAKE The hand brake, Fig. 1-11, is mounted on the front of the engine room hood and should always be released before moving the locomotive.

The hand brake is applied by turning the handwheel clockwise as far as it will go. To release the hand brake rotate the wheel counter-clockwise against the friction locks. The hand brake is connected to one brake cylinder lever only.

Apply the hand brake whenever the locomotive is to be left standing by itself for any period of time. Remove the reverse lever from the controller and apply this brake whenever anyone is working around the locomotive.

Hand Brake
Fig. 1-11

137 HORN VALVE The air chime horn is mounted on top of the carbody just forward of the rear headlight. Two pull cords located above the control stand operate the double stem air valve which allows a full or soft tone to be emitted by the horn. The front pull cord gives the soft tone while the rear pull cord gives the full tone. The horn shutoff cock is located in the

horn valve air line, slightly above the floor, in front of the controller.

138 LOCOMOTIVE BELL The signal bell is located under the carbody behind the pilot on the left side. The bell ringer valve is located to the right and below the automatic brake valve.

139 SANDING VALVE Sanding is provided on the front and rear of each truck. The sanding operating valve is located to the left and below the automatic brake valve.

140 CAB HEATERS A cab heater is placed near the top of the side of the front cab partition on each side of the operating cab. Hot water from the engine cooling system circulates through the heater elements. Motor driven fans provide air circulation for each of the heaters. Four position, three speed switches controlling the heater fans are located in the panel just above the door in the middle of the front cab partition, Fig. 1-7.

141 SPEED RECORDER The right side of the middle axle of all trucks is equipped with an adapter in the event that a speed recorder is supplied as an "extra."

142 WINDSHIELD WIPERS "Jumbo" air-push window wipers, two on each side of the cab, are provided for operator's and helper's front and rear windows. The wipers operate independently of each other. Do not run the wipers on a dry window as dirt on the glass or blade may scratch the glass. The windows are of a special "breather type" construction that are designed to eliminate their "frosting up."

143 AIR RESERVOIRS Four air tanks, connected in series are provided on the locomotive, two on each side of the underframe just below the catwalk. The first two, together, make up the No. 1 main reservoir and are located on the left side of locomotive. The second two tanks are located just under the catwalk on the right side of the locomotive and, considered together, make up the No. 2 main reservoir. Each individual tank has a 15,000 cubic inch capacity, making a total main reservoir capacity of 60,000 cubic inches. Moisture drains are provided on each tank.

144 FUEL TANK An 800 gallon fuel tank is located below the underframe just ahead of the No. 2 truck. Filling stations are provided on each side. The tank is vent equipped and includes a flame arrestor. A fuel sump is included which contains a clean-out plug and a non-removable water drain at the bottom of the tank. Two direct reading fuel gauges on each side of the tank facilitate an accurate determination of the fuel in the tank.

145 WATER TANK An 800 gallon water supply tank for the steam generator (if used) is located below the underframe just behind the No. 1 truck. Filling stations are provided on either side. If the locomotive is not equipped with a steam generator the "water supply tank" is converted into a fuel tank. In this case an equalizing line is provided between the regular fuel tank and this tank.

146 STORAGE BATTERY A 32 cell, 64 volt battery is located in four boxes. Two battery boxes are located on either side of the locomotive, below the underframe, and on the outside of the fuel and water tanks. If the locomotive is not equipped with a steam generator the entire battery is located in "steam generator compartment," behind the cab.

147 SAND BOXES Sand boxes are provided for the front and rear trucks, as shown in Chart 1. The sand capacity for the front and rear trucks is the same and is 9 cubic feet per truck.

148 FIRE EXTINGUISHERS Two (2) one-gallon CTC fire extinguishers are provided on the locomotive, one located in the cab and one in the power plant compartment. Operating instructions are given on the outside of the container and are quite simple. Everyone should feel obliged to familiarize himself with these instructions as prompt action in an emergency may prevent a tragedy.

149 TRUCKS Each locomotive unit is equipped with two special design six wheel, fully flexible three motor trucks. The truck is designed to operate on any of four different gauges of track - 4′ 8-1/2", 5′ 0", 5′ 3" and 5′ 6". This is accomplished, essentially, by varying the wheel spacing on the axle. The brake rigging and sanding arrangement is easily adjusted for the different gauges. For detailed information on the method of changing gauges on this truck, see Maintenance Instruction 1215 - MRS Supplement.

The "H" type bolster is supported by four heavy duty double coil springs mounted in spring pockets on the frame. Lateral motion is absorbed by a rubber snubber located in each of the transoms.

The truck frame is supported at four points by twin group coil springs which ride on four sets of equalizers that are carried between and rest upon the tops of the journal boxes.

Each of the three motors per truck is supported by the driving axle to which it is geared, and a nose suspension on the truck transom provides a flexible support, dampening out the torque shocks of the motor.

150 RAIL GUARD A rail guard arrangement similar to that used on European locomotives is included. Provision is made for bolting the specially designed rail guard and support onto the sander brackets when needed. Provision is also made for adjusting the rail guard height when wheels are turned, as well as adjusting the rail guard to the track gauge.

151 JOURNAL BOXES Cast steel friction journal boxes are provided for the 6-1/2" x 12" journals. For detailed information on the maintenance of these journal boxes refer to M.I. 1215 - MRS Supplement.

152 COUPLERS The locomotive is basically equipped with Type "E" couplers of standard length with a 6-1/4" x 8" shank and quadruple shear pin. The maximum swing of the coupler is 12" to each side of center. The centerline of the coupler is 34" above the rail.

Provision has been made for possible future installation of Williston automatic type couplers and buffers for foreign service.

153 STEAM GENERATOR If a steam generator is installed it will be located in the compartment just behind the cab. For information on the operation of the steam generator (if used) see Section 9 of this manual.

All MRS locomotives that do not include a steam generator as original equipment, have never-the-less been designed to permit the possible future installation of such equipment. This means that all MRS locomotives include the necessary piping for a steam generator.

If a steam generator is not included originally, the batteries will be mounted in the "steam generator compartment," rather than in the battery boxes on the outside of the fuel tank. Without a steam generator, the water supply tank under the carbody is made into an additional fuel tank.

SECTION 2

OPERATION

200 WHEN BOARDING THE LOCOMOTIVE

A. Inspect locomotive exterior and interior gear for:

1. Liquids leaking from the locomotive.
2. Loose or dragging parts.
3. Proper positioning of angle cocks and shutoff valves.
4. Worn or missing brake shoes.
5. Flat or shelled spots on wheels.
6. Proper operation of coupler knuckles at both ends of locomotive.
7. Observe brake cylinder piston travel, if brakes are set (should be approximately 2 inches).
8. Check fuel supply in sight glass on fuel tank.
9. Check water supply.
10. Check electrical power plant jumper cables, if operating a multiple unit locomotive.
11. Condition of journal boxes.

B. Inspect the operating cab as shown below:

1. Check to see that the Control and Fuel Pump Switches, in the control panel, are in the ON position. Turn ON the generator field switch only if you are ready to move the locomotive under its own power.
2. See that the throttle is in Idle and the reverse lever is in neutral.
3. Check position of the brake pipe cutout cock (double heading cock). Handle should be pointing toward the LEAD position.

4. Turn ON, or close, all switches and circuit breakers in the electrical cabinet and see that all fuses are in place.

STARTING AND STOPPING ENGINE

201 PRECAUTIONS BEFORE STARTING ENGINE

The following items should be performed when an engine is to be started after a layover. If the engine has been stopped for a period of time, less than eight hours, Item 12 may be omitted.

1. Check position of all valves: Drains in cooling system, lube oil system, and air reservoirs.

2. Check engine cooling water level.

3. Check lube oil supply:

   a. In engine crankcase.

   b. In engine governor.

   c. In air compressor.

4. Place the independent brake in full application.

5. Place the throttle in idle and remove the reverse lever from the controller.

6. Place the isolation switch in the START position.

7. Close all knife switches in the electrical cabinet (i.e. main battery, lights, control and auxiliary generator switches). Also check to see that the ground relay knife switch is closed.

8. Turn ON all circuit breaker type switches in the electrical cabinet (heaters, lights, fuel pump,

auxiliary generator field and alternator field switches).

9. See that the locomotive's only fuses are in place (starting, battery field, auxiliary generator output, boiler and hot water heater fuses).

10. With a single unit or in the lead unit of a multiple unit locomotive, turn ON the control and fuel pump circuit breaker switches at the control panel.

11. Move lever on reverser drum type switch, in the electrical cabinet, to the horizontal position - this centers, or places in neutral, the reverser switch, this must be done before the engine start switch will operate (the reverse lever in the controller must be in neutral before the reverser drum in the electrical cabinet can be manually moved to its neutral position).

12. Test for water accumulation in engine cylinders.

    a. Remove 400 ampere starting fuse.

    b. Open all cylinder test valves (2-3 turns).

    c. Rotate engine one complete revolution by use of the engine turning jack.

    d. Watch the cylinder test valves while the engine is being rotated. If water is discharged from any test valve, do not attempt to start the engine until the cause of the water accumulation has been corrected. STAND TO THE SIDE OF OPENED TEST VALVES WHILE THE ENGINE IS BEING ROTATED.

e. Close cylinder test valves.

f. Replace 400 ampere starting fuse.

202 TO START ENGINE It is advisable to start the Diesel engine only when the locomotive is standing still. After completing the check of items mentioned in Article 201 the engine is started by performing the following items (for information on the steps to be taken when starting the engine in severe cold weather, see Section 8).

1. Check to see that fuel is flowing through the fuel filter, as will be indicated by the flow of fuel through the sight glass nearest the engine.
2. Check to see that the overspeed trip is in the latched position, Fig. 10-21.
3. Check the governor low oil alarm trip button to see that it is "set," Fig. 10-22.
4. Place isolation switch in the START position.
5. Center the handle on the reverser drum (handle horizontal, Fig. 3-1).
6. Press IN the engine start button until the engine completely starts (not more than 15 seconds). In cold weather it is advisable to have someone push in the engine layshaft until the fuel pointer on the governor is at the "15" or "16" mark.
7. Watch engine oil pressure gauge to see that the pressure builds up. The governor will shut the engine down in about 40 seconds if the oil pressure does not become normal.
8. Check the starting contactors to see that they did not stick closed. (The contactors should be open and the interlocks closed, Fig. 10-20).

9. Check the Ground Relay to see that it is set.
10. Idle engine until temperature becomes normal.
11. See Section 10 for information on possible troubles in starting if this should be experienced.

203 PLACING AN ENGINE ON THE LINE After the oil pressure has built up and the engine has been "warmed up" the engine is placed "on the line" (connected to throttle control), by merely turning the isolation switch to the RUN position.

204 TO STOP ENGINE There are three accepted ways of stopping the engine.

1. Place the isolation switch in the START position and press IN the STOP button, on the engine control panel, until the engine stops.
2. All engines in the consist may be stopped by depressing emergency STOP button on the end of throttle lever, and pushing the throttle lever as far forward as possible. This action will shut down those engines in the consist whose isolation switches are in the RUN position. The alarm bells will ring and the purple alternator failure lights will be lit when engines are stopped in this manner; placing the fuel pump switch in the OFF position at the engineer's control panel will extinguish the alarm.
3. The engine may also be shut down by pulling the engine layshaft to the No-Fuel position and holding it in this position until the engine stops.

205 SECURING LOCOMOTIVE FOR LAYOVER

1. Shut the engine(s) down.
2. Turn off all switches at the engineman's control panel.

3. Remove reverse lever from controller.
4. Open all circuit breakers and switches in the electrical cabinet.
5. Set hand brakes.
6. If necessary, protect engine from freezing according to Article 221.
7. Cover exhaust stacks when locomotive is left outside if there is danger of a severe rainstorm.

HANDLING LOCOMOTIVE

206 PRECAUTIONS BEFORE MOVING LOCOMOTIVE

1. NEVER move a locomotive, under its own power, without having first checked the proper application and release of the brake shoes.
2. Check the main reservoir and the control air pressure (these gauges should indicate 140 and 90 psi respectively).
3. Release hand brakes.
4. Engine cooling water should be 120° or more.

207 HANDLING LIGHT LOCOMOTIVES With the engine placed on the line and cab preparations completed the locomotive is handled as follows:

1. Turn ON generator field switch.
2. Insert and move the reverse lever to the desired direction. (This lever is to be moved ONLY when the locomotive is standing still).
3. Place the isolation switch in the RUN position.
4. Depress safety control foot pedal.
5. Release the air brakes.

6. Open throttle a notch at a time. Jerk throttle gently, one notch and release; this permits the lever to be reset for the next notch.

7. Note that the locomotive rolls freely and care should be used in judging the speed.

8. The throttle must be in IDLE before coming to a dead stop.

208 COUPLING TO TRAIN AND PUMPING UP AIR After coupling to train, stretch coupling to insure couplers are properly locked. Following this, make air and steam (if used) connections.

1. Valves and cocks:

   a. The brake pipe cutout cock is beside the coupler.

   b. The signal line cutout cock is below the coupler. (The signal whistle cutout cock is on the signal line reducing valve on the air brake rack).

   c. A globe valve is on each end of the steam trainline, behind the end plate at either end of the unit. The steam generator stop valve-15 is on the steam generator.

2. If main reservoir pressure falls below feed valve setting when the brakes are cut in, proceed as follows:

   a. Turn OFF generator field switch.

   b. Place reverse lever in NEUTRAL.

   c. Open throttle to 4th, 5th or 6th notch as needed (as main reservoir pressure builds up, reduce the throttle).

109 STARTING A TRAIN Starting a train depends largely on the tractive effort of the locomotive

being used. Besides this, the grade and weather conditions as well as the type, length, weight and amount of slack in the train all affect the ability of the locomotive to start the train. Because of this locomotive's HIGH STARTING TRACTIVE EFFORT it is important that the air brakes be completely released before attempting to start the train. Actual tests show that a 100 car train having average leakage, may require 9 minutes to completely release the brakes. It requires a longer period of time to completely charge a depleted air system on a similar train.

The load indicating meter can be used as a PULL METER to judge the tractive effort of the locomotive; the tractive effort increases with the amperage. Merely looking at the ground and listening to the engine exhaust may give a false indication of the locomotive's tractive effort.

The MRS is designed to GRADUALLY BUILD UP POWER in starting. A device called the load regulator determines the rate of increase in the generator output while the throttle determines the extent of that output. Thus, if the throttle is opened rapidly the rate of power build-up is controlled by the load regulator and a smooth start is assured. The load regulator makes it unnecessary to try to load the engine by "pumping" the throttle from one position to another.

When ready to start the train, proceed in general, as follows:

1. Turn ON the generator field switch.
2. Move the reverse lever to the desired direction.
3. Depress the safety control foot pedal and release the air brakes.
4. Open the throttle one notch every 1 to 2 seconds. At an easy starting place the locomotive may start the train in Run 1 or 2. It is gen-

erally unnecessary to go above the 3rd notch but experience and the per cent of grade on which the train is being started will determine this.

5. After the train starts moving, reduce the throttle one or more notches if there is slack in the train and the acceleration is too rapid.

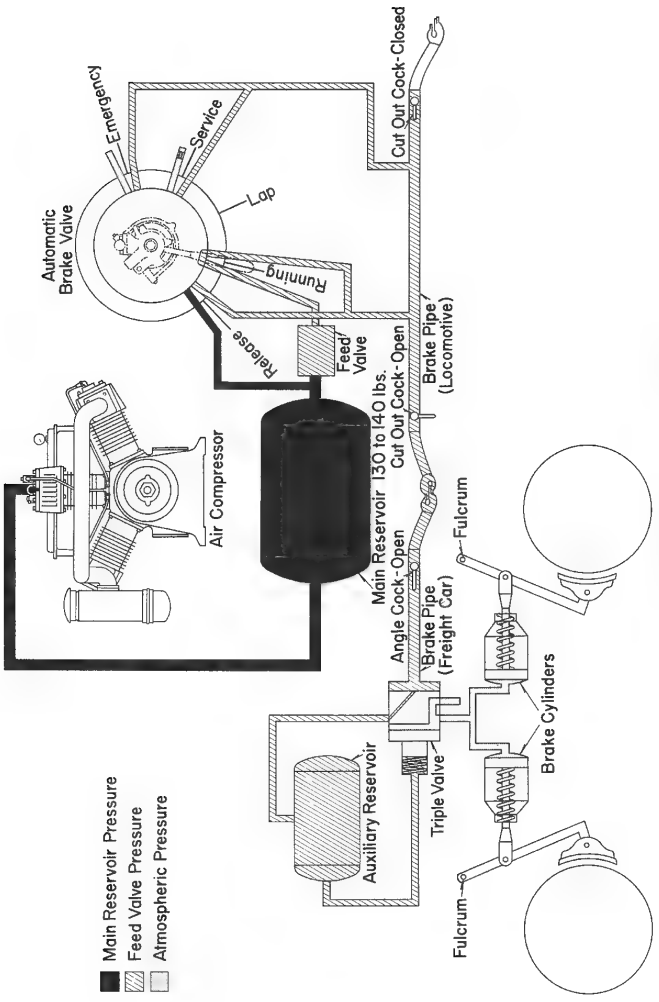
6. After the train is stretched, advance the throttle as desired. A smooth acceleration is obtained by opening the throttle one notch each time the pointer of the load meter begins moving to the left; this tends to keep a steady pull on the train during its acceleration.

NOTE: If the wheel slip indicator flashes repeatedly, reduce the throttle one notch. Apply sand as needed to prevent further slipping and reopen the throttle when rail conditions improve.

BRAKING

As there are many variations possible or necessary in the handling of the air brake equipment, depending on the area of operation, no attempt is made in this manual to give any definite operating instructions. This also applies to the possible future inclusion of vacuum air brakes. A schematic of the basic automatic air brake is shown in Fig. 2-1. A schematic of the air brake piping and equipment is shown on Page 701.

210 AIR BRAKING WITH POWER When braking with power it must be remembered that for any given throttle position, the draw bar pull rapidly increases as the train speed decreases. This pull might become great enough to part the train unless the throttle is reduced as the train loses speed. Since the load meter indicates the PULL of the locomotive, the engineman can maintain a constant pull on the train during a



Basic Automatic Air Brake
Fig. 2-1

slow down, by keeping a steady amperage on the load meter. This is accomplished by consecutively reducing the throttle a notch whenever the amperage starts to increase. It is recommended that the independent brakes be kept fully released during power braking. The throttle MUST be in Idle before the locomotive comes to a stop.

MISCELLANEOUS OPERATING INSTRUCTIONS

211 WHEEL SLIP INDICATION If wheel slipping occurs, one of the three wheel slip relays (WSR 1, 2 or 5), located in the rear of the electrical cabinet, will "pick up". This will reduce the engine speed 150 RPM and will light the wheel slip indicator on the control panel. Wheel slip relay action automatically reduces the main generator power output, thereby reducing the traction motor torque to stop the slipping.

It will generally be unnecessary to reduce the throttle because of momentary wheel slip action, as the locomotive will automatically reduce its power to stop the slipping and reapply the power after the slipping has stopped. However, under extreme rail conditions, repeated and consecutive slipping may occur. In this case the throttle should immediately be reduced to a position which will apply the maximum power possible without causing slipping. SAND SHOULD BE USED TO PREVENT SLIPPING, NOT TO STOP IT.

212 INDICATION OF A PAIR OF WHEELS SLIDING If one pair of wheels should slide when starting a train, the wheel slip light will flash on and off intermittently. As the train speed increases, the light will stay on more or less continuously and will not go out when the throttle is reduced. The light will go out when throttle is closed to idle.

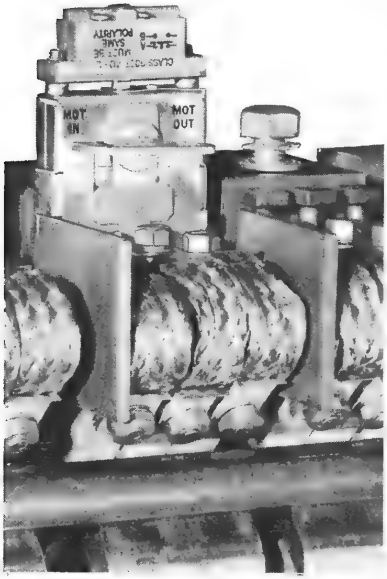
If this happens, the engine crew should make an immediate investigation to determine the cause. The

wheels may be sliding due to a locked brake, a broken gear tooth wedged between the pinion and ring gear, etc.

Repeated ground relay action, accompanied with unusual noises such as continuous thumping or squealing, may also be an indication of serious traction motor trouble that should be investigated at once.

IF A POWER PLANT MUST BE ISOLATED BECAUSE OF REPEATED WHEEL SLIP OR GROUND RELAY ACTION, DO NOT ALLOW THAT UNIT TO REMAIN IN LOCOMOTIVE CONSIST UNLESS IT IS CERTAIN THAT ALL OF ITS WHEELS ROTATE FREELY.

213 GROUND RELAY ACTION Pointer points to yellow dot when set, and to a red dot when tripped. When the ground relay is tripped the engine will not speed up when throttle is opened. In No. 5 or 6 throttle position the engine will stop and the purple light will light. To reset, isolate engine, reset relay, and put engine on line. If relay continues to trip isolate unit, Art. 320.



Motor Cutout Switches
Fig. 2-2

214 MOTOR CUTOUT SWITCHES

These motor cutout switches (MC01, MC02, and MC05) are mounted on the reverser drum. Each switch per-

mits the isolation of two traction motors following a minor failure or emergency, in case it is desired to move the locomotive under its own power. MC01 permits the cutting out of power to motors No. 1 and 4. MC02 permits the cutting out of power to motors No. 2 and 3. MC05 permits the cutting out of power to motors No. 5 and 6. Always isolate the engine before opening a motor cutout switch.

215 OPERATING OVER RAILROAD CROSSINGS

When crossing railroad crossings, reduce throttle to the 5th notch before reaching crossing and leave reduced until all units are over crossing. This will reduce arcing from the brushes to the motor commutator.

216 RUNNING THROUGH WATER Under ABSOLUTELY no circumstances should the locomotive pass through water which is deep enough to touch the bottom of traction motor frames. When passing through water always go at a very low speed (2 to 3 miles per hour). Water any deeper than three inches above the top of the rails is likely to cause damage to the traction motors.

217 DOUBLE HEADING Prior to double heading behind another locomotive, make a full service brake pipe reduction with the automatic brake valve and close the double heading cock. Return the automatic brake valve handle to the running position and place the independent brake valve in release position. The operation of the throttle is normal, but the brakes are controlled from the lead locomotive. The engineman on the second locomotive may make an emergency application of the brakes with automatic brake valve, and/or may release his locomotive brakes by depressing the independent brake valve handle, in the release position.

218 ISOLATING AN ENGINE Placing the isolation switch of any unit in the START position disconnects the engine in that unit from the control of the throttle. This, of course, eliminates the development of power in the unit although other units connected to this unit, having their isolation switches in the RUN position, are still under the control of the throttle.

It is permissible to isolate a unit underway, since the reverser drum in each unit operates according to the position of the reverse lever in the controller, regardless of the position of the isolation switch (with the exception of the reverser drum going to neutral when the reverse lever is in neutral).

If a engine is isolated and shut down while underway it is advisable not to attempt starting the engine until the locomotive has been stopped, and the reverse lever, in the controller, placed in the neutral position, or removed.

219 TOWING LOCOMOTIVE

1. If an MRS-1 locomotive is to be moved by some other form of power such as a yard engine, the reverse lever (in the controller) must be: (a) placed in direction of locomotive movement, or (b) removed from the controller and the reverser drum in each unit placed in the neutral position by use of the manual lever attached to the left hand side of the reverser drum (the reverser drum is in neutral when the manual lever is in the horizontal position). The reason for this is to keep the traction motors from acting as generators and thereby resisting any movement of the locomotive if it is towed in a direction opposite to the position of the reverser.
2. If the locomotive is to be towed an appreciable distance, the reverser drum type switch must

be locked in the neutral position. This is done by (a) centering the reverser, (b) placing the locking pin into the hole on the bottom right hand side of the reverser housing, through the hole in the reverser shaft and (c) screwing the pin into the threaded hole in the top side of the reverser housing. During normal operation the locking pin is stored by being screwed into the tapped hole on the top right hand side of the reverser housing, as shown in Fig. 3-1.

The isolation switch in each unit being towed must be placed in the START position. If it is necessary to keep the engines idling for any reason while towing the locomotive, the fuel pump and control switches should be left in the closed position.

The air brake equipment should be set according to the air brake manufacturer's bulletin.

220 RECOVERY OF BRAKE AFTER PENALTY APPLICATION

1. Place automatic brake valve in LAP.
2. CLOSE THROTTLE TO IDLE.
3. Place foot on safety control foot pedal.
* 4. Wait until application pipe builds up to main reservoir pressure. (Listen for exhaust or watch PCS light).
* 5. Release brakes.

*If PCS will not reset (i.e. light stays lit) with automatic brake valve handle in LAP, after an emergency application, place brake valve handle in running position.

221 FREEZING WEATHER PRECAUTIONS In freezing weather, care must be taken to see that any water in the locomotive does not freeze. If the cooling system is filled with an anti-freeze solution, the solution should be checked according to the specifications of the anti-freeze manufacturer to see that the proper protection of the cooling system is afforded for the lowest possible temperature anticipated.

If the engine is to be shut down and the cooling system is NOT filled with an anti-freeze solution, the entire cooling system will have to be drained. The entire cooling system will drain through the engine drain valve, with the exception of the water trapped in the water pump housing on the front right hand side of the engine. To drain the right hand water pump open the drain in the bottom of the water pump housing to prevent its freezing. The engine cooling system drain valve is located inside the engine room, immediately below the No. 1 hot water heater.

If the locomotive is equipped with a steam generator, care must be taken to see that any water in the steam generator, piping and water supply tank does not freeze. This may be accomplished by either admitting steam from the trainline to the radiation and water supply tank, or draining all water from the system. For further information see Section 9.

When shutting a locomotive down for an extended layover in freezing weather it is wise to make a check of the specific gravity of the batteries to be sure that they will be in no danger of freezing. The freezing temperature of the battery electrolyte at various states of charge is given in the battery Maintenance Manual.

222 SPLITTING AND JOINING UNITS

1. Take down all power plant jumper cables.
2. Close angle cocks on both units on all air hoses.

3. Break hoses and separate units by uncoupling.

4. In joining units:

   a. Stretch units to insure couplers are locked.

   b. Connect hoses and jumpers, and be sure all angle cocks on all air hoses are opened in both units.

   c. In any non-operating cab, cut out the brakes and turn off all switches at the engineman's control panel. Remove the reverse lever from the controller in all trailing units.

223 MULTIPLE UNIT OPERATION The Model MRS-1 locomotive is designed to operate in multiple unit service with any other model locomotive provided with 6 BL (or comparable) air brake equipment and equipped for multiple unit operation with 27 point power plant jumper cable receptacles.

After coupling the units together and connecting the power plant jumper cable, brake hoses and steam trainline (if used) between units, the controls are set as outlined in Article 224. The locomotive is then operated according to normal procedure. If any of the units in the consist should include a Road Service (fast or slow starting feature) switch, it is generally advisable to place this switch in the slow starting (road) position.

224 CHANGING OPERATING CABS When the consist of the locomotive includes two or more units, the following procedure should be followed in changing operation from one cab to another.

1. Remove reverse lever.

2. Make a full service brake pipe reduction.

3. Move brake pipe cutout cock (double heading cock) to the trailing position (TRLG); this

valve is located beneath a small trap door in the floor of the cab, Fig. 1-8.

4. Move the independent brake valve handle to RELEASE position.

5. Leave the automatic brake valve handle in the LAP position.

6. Open all switches at engineman's control panel ("Off" position).

7. Place the headlight control switch in the position marked CONTROLLED.

8. Place the transition forestalling switch in the desired position, SERIES or AUTOMATIC.

9. Proceed to the cab which is to be made operative. Close control and fuel pump switches ("On" position) and any other switches that are necessary.

10. Insert reverse lever and brake valve handles. Place independent brake valve in full "application" position.

11. Open double heading cock to the Lead position slowly.

12. Place the headlight control switch in the proper position, according to the instructions given on the face of the switch; the No. 1 end is the long hood end of the locomotive.

13. Place the transition forestalling switch in the desired position, SERIES or AUTOMATIC.

14. When ready to move locomotive, turn on the generator field switch, depress safety control foot pedal, move independent brake valve to "RELEASE" position.

NOTE: When hauling locomotive "dead", place the independent and automatic brake valve handles in the RELEASE and RUNNING positions, respec-

tively, move the double heading cock to the DEAD position, and move the dead engine cock from the LIVE position to the LEAD position.

The brake pipe cutout cock (double heading cock) is mounted on the N-1-A brake application valve. The N-1-A brake application valve is located under the operating cab and can be reached through a small trap door in the operating cab floor, Fig. 1-8.

NOTES

SECTION 3

ELECTRICAL EQUIPMENT

300 GENERAL ELECTRICAL SCHEME The horsepower of the engine is delivered to the direct coupled main generator. At the main generator the mechanical power of the engine is transformed into electrical power. The electrical power is then conducted to the six traction motors, three motors being located in each truck (each motor being geared to an axle).

The locomotive is designed so that within the current and voltage limits of the main generator, the power (KW) delivered to the traction motors at full throttle, is the same, regardless of the locomotive's speed.

The electrical system of the locomotive can be thought of as being divided into three separate systems:

1. High voltage system
2. Low voltage system
3. Alternating current system

The high voltage system is directly concerned with moving the locomotive. The high voltage system is composed of the main generator, traction motors, forward transition relay, shunt field contactor, motor shunting contactors, reverser drum, wheel slip relays, and the ground relay.

The low voltage system contains the control circuits which control the flow of power in the high voltage system, and those auxiliary circuits which conduct power to the lights, heaters, fuel pump and main generator battery field. A 64 volt storage battery is the initial source of low voltage and it is from this source

that power is taken to start the engine. Once the engine is started, the auxiliary generator takes over the job of supplying power to the low voltage system and charging the battery.

The alternating current system includes an alternating current generator (called an alternator) which delivers power to but two important items: (1) the four engine cooling fan motors, and (2) the six traction motor blower motors. The alternating current system provides a means of electrically driving accessories at speeds which vary according to the engine speed.

301 MAIN GENERATOR The main generator is driven at engine speed and is a constant KW generator whose voltage is nominally 600 volts. The voltage varies with the conditions of operation of the locomotive (engine and locomotive speed and traction motor electrical connections).

The main generator contains six field windings: battery, shunt, differential, compensating, commutating, and starting fields. With regard to locomotive operation, the shunt and battery fields are the more important; these two fields provide the major excitation of the main generator. The starting field is used only when the main generator is used as a starting motor to rotate the engine.

The battery field is a low voltage, externally excited field. The current flowing through the battery field provides the initial excitation of the main generator. The load regulator varies the excitation of the battery field and thereby regulates the power output of the main generator. The battery field contactor opens or closes the circuit to the battery field.

The main generator is self excited to the extent of the excitation produced in the shunt field. The shunt

field is a high voltage field and its excitation varies with the voltage of the main generator. A shunt field contactor opens or closes the circuit to the shunt field. Interlocks in the shunt field contactor are connected so that this contactor must close before the battery field contactor can close.

The differential, compensating and commutating field are permanently connected and are a matter of engineering design providing desired generator characteristics and proper commutation.

302 ALTERNATOR The alternator (alternating current generator) is a 16 pole, 149 volt, 3 phase, wye (Y) connected assembly driven at engine speed. The stator is bolted directly to the main generator frame; the rotor, or rotating field assembly is mounted on the same shaft with the main generator armature. The alternator field current is supplied directly and ONLY from the auxiliary generator and is set to a predetermined value by means of a fixed external resistor in this circuit.

The alternator's only purpose is to supply alternating current power to the engine cooling water fans and to the traction motor blower motors.

Since it is important that the traction motors be cooled whenever the engine is running, the traction motor blowers are directly connected to the alternator output without any switches in the line. A No-Voltage Relay (NVR) is connected to the alternator output to automatically give an alarm and reduce the engine speed to idle in case these blowers should stop running because of a lack of AC power.

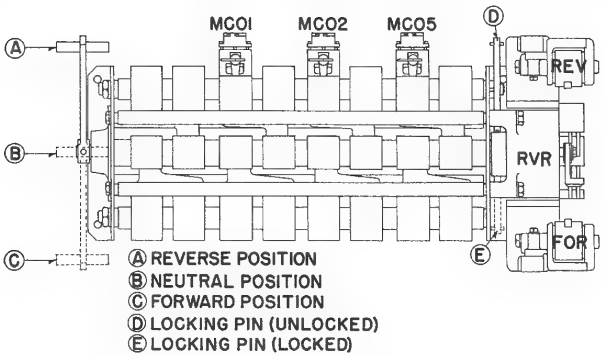
The engine cooling fans are also connected to alternator but switches are included so that fans may be controlled thermostatically or manually, see Art. 400.

303 TRACTION MOTORS The traction motors are direct current, series wound motors geared to the axles. The motors are reversed by changing the direction of current flow in the field windings, the direction of current flow in the armature always being the same. A reverser drum operated by electro-pneumatic control reverses the current flow in the traction motor field windings.

The traction motors are cooled by alternating current driven blowers, one for each motor. These blowers are mounted on the floor of the engine room and blow air through flexible ducts to the traction motors. The speed of the blowers varies with the speed of the engine; this is caused by the engine speed varying the frequency of the alternator.

The maximum permissible top speed of the locomotive is determined by the maximum safe RPM of the traction motors; with the gear ratio used on this locomotive the maximum permissible speed is 77 MPH.

304 REVERSER Movement of the reverse lever in the controller to the forward or reverse position energizes the respective FORward or REVerse magnet valves on the reverser drum located in the

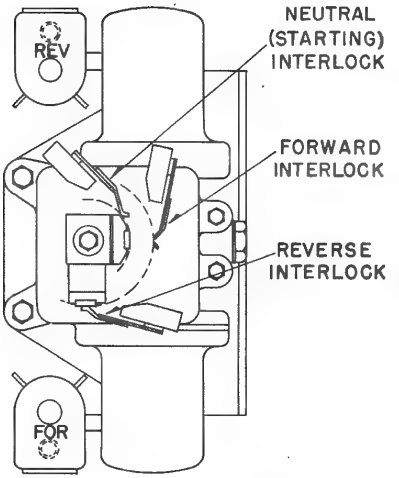


Reverser
Fig. 3-1

electrical cabinet, Fig. 3-1. When either of the magnet valves is energized, control air is allowed to pass through the valve, moving the reverser drum to the desired position (with four long segments showing on the drum, the reverser is in forward; eight short segments are seen in the reverse position).

Three interlocks are located on the right side of the reverser. These are called the forward, reverse, and engine starting (or neutral) interlocks, Fig. 3-2. The proper interlock must be closed in order to accomplish the desired operation. Since the traction motors are permanently connected in a series-parallel circuit to the main generator and the reverser is the only way of disconnecting the motors from the generator, a handle (lever) is attached to the left hand end of the reverser drum shaft to permit turning the reverser drum to its neutral position (handle horizontal) when starting the engine.

NOTE: The reverser drum cannot be placed in neutral unless the reverse lever in the controller is in its neutral position — this de-energizes the reverser magnet valves.



Reverser Interlocks
Fig. 3-2

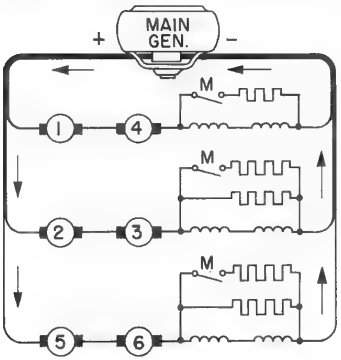
A starting interlock mounted on the reverser drum is closed in the neutral position; if one forgets to move reverser drum to neutral when starting the engine, starter button will have no effect. If the reverser drum should not close the forward or reverse interlocks (depending upon the direction in which the particular unit is moving) no power will be delivered by the unit.

When the locomotive is to be towed, the reverser drum MUST be locked in the neutral position by use of the locking pin, Fig. 3-1 (see Art. 219).

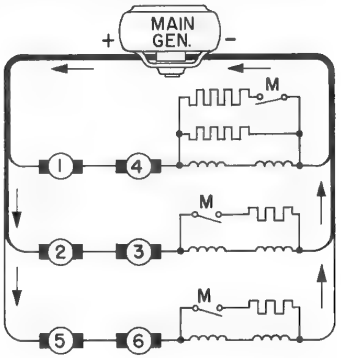
305 TRANSITION This term is applied to the changing of traction motor electrical connections on a Diesel-Electric locomotive; this is to allow full power to be obtained from the main generator within the range of its current and voltage limits. Transition adjusts the traction motor "back pressure" (counter-e.m.f.) so that it will not become too high at higher speeds nor too low at lower speeds.

On this locomotive transition consists of changing the traction motor electrical connections from series-parallel to series-parallel-shunt. This is done automatically when the transition forestalling switch is placed in the AUTOMATIC position, or may be forestalled by placing the switch in the SERIES position. Figures 3-3 and 3-4 show the traction motor electrical connections in forward and reverse, respectively.

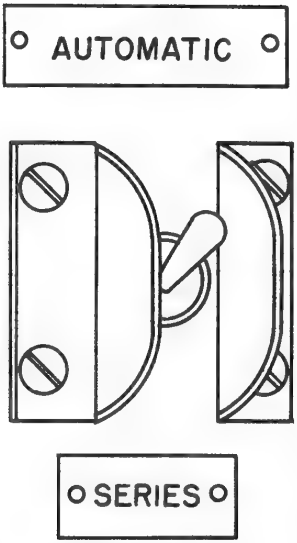
Because of the inherent weight transfer in the truck, the electrical system has been designed to de-



Motor Connections Forward
Fig. 3-3



Motor Connections Reverse
Fig. 3-4



Forestalling Switch
Fig. 3-5

liver more power initially to those axles which will be more heavily loaded. This is accomplished by shunting the fields of the heavily loaded motors (axles) approximately 28% at the start. When the speed of the locomotive has increased so that the main generator voltage reaches 800 volts, the forward transition motor shunting relay (FTM) "picks up" and causes the motor shunting contactor (M) to close; this happens at about 23 MPH in Run 8. When the "M" contactor, Fig. 3-7, closes, it causes the fields of all six motors to be shunted approximately 56% (this means that those fields which were initially shunted 28% have sufficient resistance combined with the original 28% shunt to make a total of 56%; the previously unshunted fields are shunted an approximate full 56%). The transition forestalling switch, of course, must be in the AUTOMATIC position before the FTM can cause the "M" contactor to close. The FTM relay "picks up" at 800 volts and "drops out" at 560 volts. The "M" contactor opens when the FTM drops out; this will happen in full throttle when the locomotive speed drops below 19.5 MPH.

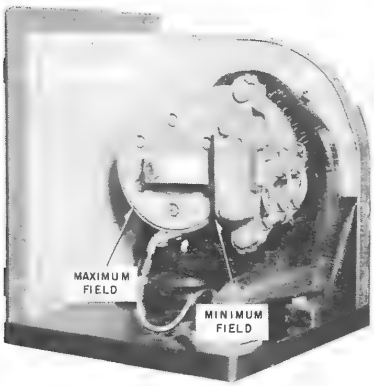
306 TRANSITION FORESTALLING SWITCH This switch is located on the side of the controller and has two positions up-AUTOMATIC and down-SERIES, Fig. 3-5. When the switch is in the up-AUTOMATIC position, transition will take place automatically. If transition is not desired the switch is placed in the down-SERIES position; transition will then not take place, regardless of locomotive speed or generator voltage.

The transition forestalling switch may be moved from one position to the other at any time, without detrimental effect on the equipment. Movement of the switch from the SERIES to the AUTOMATIC position will not cause the "M" contactor to close, unless the FTM has already "picked up."

307 LOAD REGULATOR The load regulator, Fig. 3-6, is an automatically operated rheostat connected in series with the main generator battery field. Engine oil pressure is used to move the rheostat, as directed by a pilot valve in the engine governor, loading the engine according to the throttle setting in the cab.

The load regulator has two components: (1) the pilot valve in the engine governor, and (2) a self-contained unit consisting of an hydraulic vane type motor attached to the commutator type rheostat. The only external wiring connections are two leads to the generator battery field circuit.

For the purpose of load regulation, the engine horsepower output is determined by the rate of fuel consumption. Thus, for each throttle position (as shown on the governor) there is a definite fuel consumption as indicated by the position of the governor power piston, which controls opening of the injector racks. If the load of the engine should be such that more fuel (consequently, power) is demanded than the predetermined balance point (between load and fuel



Load Regulator
Fig. 3-6

consumption), the load regulator will automatically reduce the engine load by reducing the battery field strength. This reduces the fuel consumption, and correspondingly, power output.

If the engine requires less fuel than the predetermined setting, the load regulator increases the load on the engine by increasing the battery field excitation of the main generator. In this manner, battery voltage, temperature changes in the generator windings, or locomotive speeds do not cause overloading or underloading of the engine and a constant power output is maintained for each throttle setting.

An overriding solenoid, ORS, in the governor is energized whenever the battery field contactor, BF, is open or the wheel slip auxiliary relay, WSA, is energized. Thus, during wheel slip action or when the throttle is in Idle, the ORS will be energized. The energizing of this solenoid causes the load regulator to move into or toward the minimum field position, depending upon the length of time that the ORS is energized.

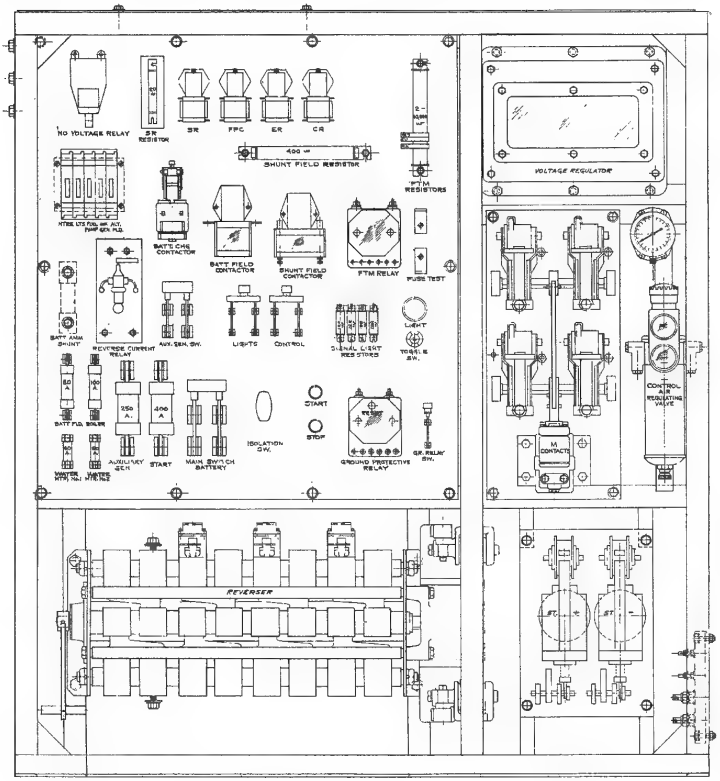
308 BATTERY FIELD CONTACTOR AND FUSE

When the throttle is moved to Run 1 this contactor closes and connects low voltage to the main generator battery field; the amount of excitation of the battery field depends upon the load regulator position; a selenium rectifier and discharge resistor are used to dissipate the high voltage induced in the battery field when the BF contactor is opened.

An 80 ampere battery field fuse, located in the electrical cabinet protects the battery field circuit from any possible overload. If this fuse is blown the unit will develop very little power. ONLY remove and replace this fuse if the isolation switch is in the START position.

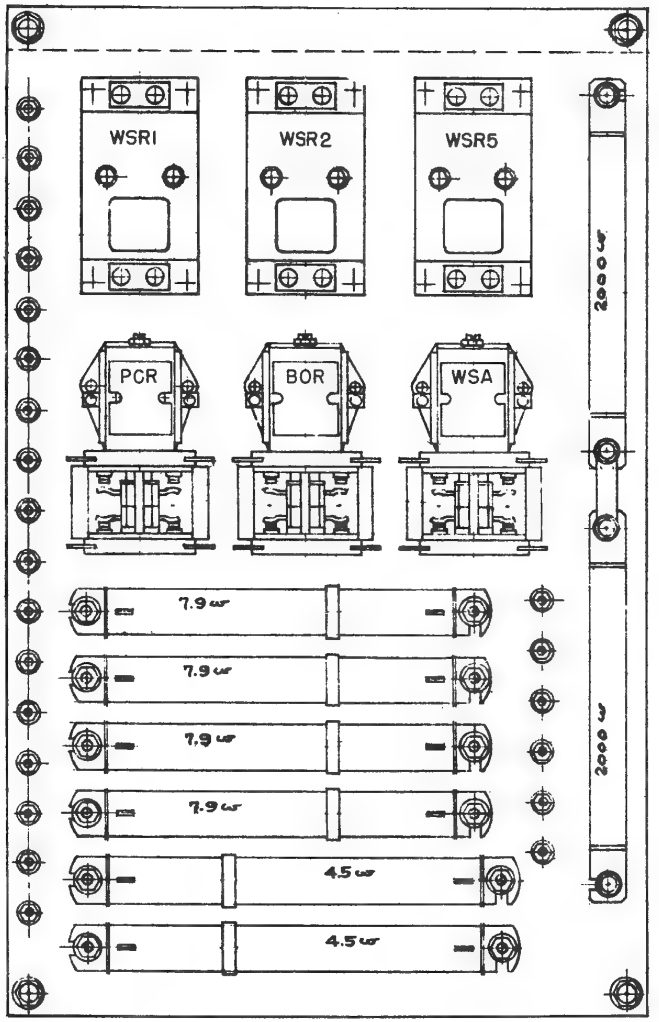
309 MAIN BATTERY SWITCH This switch is located on the distribution panel and connects the 32 cell, 64 volt battery to the low voltage circuits. An external charging receptacle is located on both sides of the locomotive.

310 BATTERY AMMETER The battery ammeter is located on the rear wall of the cab. This ammeter is located above front side of the electrical cabinet. This ammeter only shows whether the battery



Electrical Cabinet — Front
Fig. 3-7

is charging or discharging. Normally the meter will indicate zero or a slight charge.



Electrical Cabinet — Rear
Fig. 3-8

311 REVERSE CURRENT RELAY (RCR) This relay, located on the distribution panel, controls the opening and closing of the battery charging contactor (BC). The RCR causes the BC contactor to open when the auxiliary generator voltage drops below the battery voltage. This prevents a reverse flow of current from the battery attempting to "motor" the auxiliary generator.

312 BATTERY CHARGING CONTACTOR (BC) This contactor is an electrically operated switch connecting the auxiliary generator output to the low voltage system. The reverse current relay controls the operation of the battery charging contactor.

313 BATTERY CHARGING FUSE This fuse protects the auxiliary generator against any possible overload. A blown battery charging (auxiliary generator output) fuse will cut off the auxiliary generator from the low voltage system and force the battery to supply the low voltage requirements. Only remove or replace this fuse after isolating the engine and opening the auxiliary generator switch.

314 AUXILIARY GENERATOR FIELD SWITCH A 30-ampere circuit breaker protects the auxiliary generator field windings against excessive current. "Tripping" of this circuit breaker prevents the auxiliary generator from supplying current to low voltage system.

315 VOLTAGE REGULATOR A voltage regulator, Fig. 3-9, is connected in the auxiliary generator circuit and maintains its voltage at 74 volts by varying the field strength of the auxiliary generator.

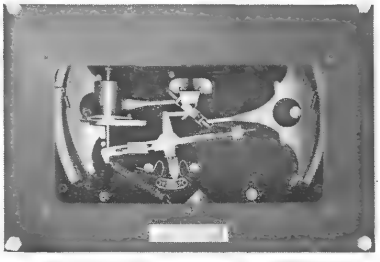


Fig. 3-9

316 ENGINE SPEED CONTROL Movement of the throttle lever operates a drum contactor. In throttle positions 2 to 8, the contactor energizes one or more of four wires AV, BV, CV and DV, which run throughout the locomotive. In each unit taps from the wires run to the A, B, C and D solenoids in the Electro-hydraulic speed control portion of the governor.

The table below shows the solenoids which are energized for each throttle position and the corresponding engine speeds.

ENGINE SPEED CHART

THROTTLE POSITION	SOLENOIDS ENERGIZED A	B	C	D	ENGINE SPEED RPM
STOP				*	0
IDLE					275
1					275
2	*				350
3			*		425
4	*		*		500
5		*	*	*	575
6	*	*	*	*	650
7		*	*		725
8	*	*	*		800
Effect of Solenoids on Engine RPM	+75	+300	+150	-150 (or stop)	

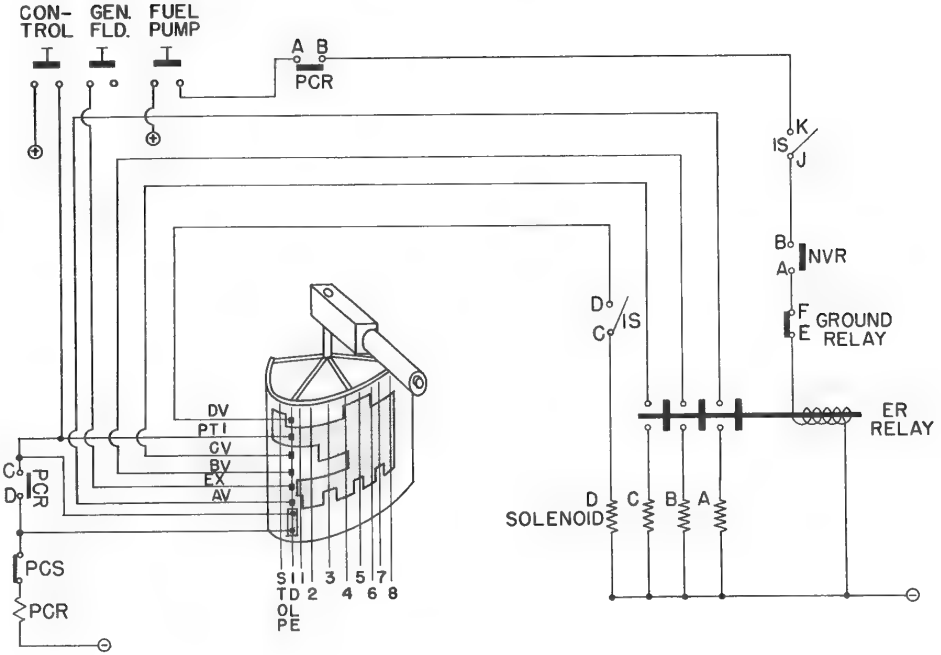
317 ENGINE RELAY (ER) This relay controls the current supply to the "A," "B" and "C" solenoids of the electro-hydraulic governor control. De-energizing this relay will stop the engine if the throttle is in Run 5 or 6, or bring the engine to idle in any other throttle position. This relay is in the electrical cabinet.

For operation of the speed control in any one unit, the ER Relay must be energized and closed. The relay has contacts which open, when the relay is de-energized, and they interrupt the circuits supplying the A, B and C solenoids, of the governor speed control. It has no effect on the circuit to the D solenoid. Thus, de-energizing the ER relay will cut out the A, B and C solenoids and bring the engine to idle speed if the throttle is in Runs 2, 3, 4, 7 or 8. Should the ER relay become de-energized when the throttle is in Run 5 or Run 6, the D solenoid will remain energized and cause the engine to stop.

The ER relay in each unit is energized by current received from the FP wire that runs throughout the locomotive. The 15 ampere fuel pump circuit breaker, on the control panel, and the PCR interlock, AB, in the lead unit must be closed in order to energize the FP wire; the PC switch, the main battery and control knife switches, and the 30 ampere control circuit breaker, on the control panel, must also be closed.

The ER relay in each unit will become de-energized from any of the following causes:

1. Isolation switch not fully in the RUN position.
2. Failure of the AC supply, causing the NVR relay to open.
3. Ground protective relay, GR, tripped.
4. Fuel pump circuit breaker (15 ampere) open.
5. Control circuit breaker (30 ampere) open.
6. PC switch tripped open; PCR de-energized.
7. Control knife switch open.



ER Relay Circuit
Fig. 3-10

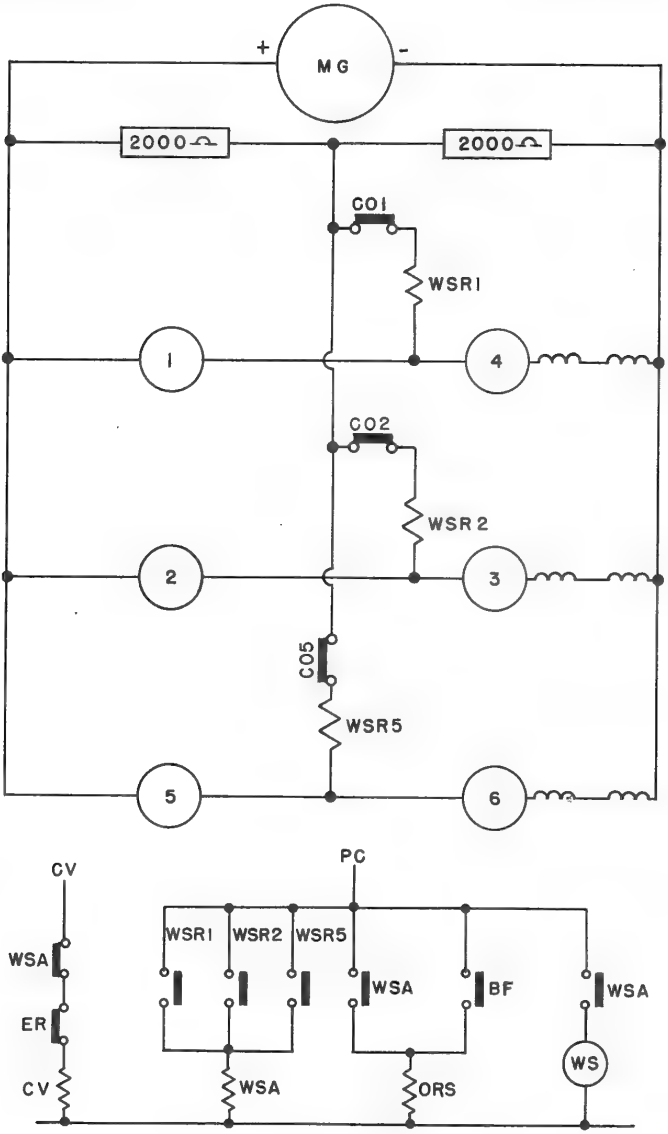
8. Main battery switch open.

When the throttle is moved to the STOP position it will cause the "D" solenoid to be energized in all units in which the isolation switch is in the RUN position; this causes the engine in those units to stop.

A fifth solenoid (O or ORS) is included in the governor which affects engine loading only and does not change engine speed.

318 WHEEL SLIP CONTROL If a pair of wheels should slip, one of the three wheel slip relays (WSR1, WSR2, or WSR5) will "pick up," due to a difference in potential between points across which it is connected. When a wheel slip relay is energized its normally open interlock closes and energizes the wheel slip auxiliary relay, WSA, as shown in the diagram, Fig. 3-11. The WSA relay has three interlocks in the circuit, two normally open and one normally closed, which close and open, respectively, when the relay is energized. When the two normally open interlocks close, one of them causes the wheel slip light to turn on, while the other interlock causes the overriding solenoid, ORS, to be energized; energizing the ORS causes the load regulator to move toward the minimum field position. When the normally closed WSA interlock opens, it interrupts the flow of current to the "C" solenoid, CV, in the governor. When the "C" solenoid is energized it adds 150 RPM to the engine speed, thus when it is de-energized it drops the engine speed the same amount. Since the "C" solenoid is energized in all throttle positions except Run 1 and 2, the engine speed will invariably be dropped 150 RPM when slipping occurs, as slipping will infrequently occur in Run 1 or 2.

When the applied power has been reduced to the point where the slipping stops, the affected wheel slip relay will "drop out" and the normal output of power will be restored.



Wheel Slip Control Schematic
Fig. 3-11

319 ISOLATION SWITCH The switch has two positions - "START" (handle horizontal) and "RUN" (handle vertical). With the switch in "START" position the power plant is disconnected from those in the other units and is said to be "isolated." The engine will remain at idling speed and will not respond to throttle control. The SH and BF contactors in the electrical cabinet will not operate when the throttle lever is moved. The "ALTERNATOR FAILURE" alarm is inoperative. The "START" and "STOP" buttons are effective only when the isolation switch is in the "START" position.

320 GROUND RELAY (GR) The ground relay, located in the electrical cabinet, Fig. 3-7, is an electrical protective device connected to the high voltage system. The function of this relay is to automatically unload the main generator in case of a ground in the high voltage system (a ground can be defined as current passing through the frame, or carbody, of the locomotive).

If a ground in the high voltage system should occur, the ground relay will "trip" and light the white ground relay indicating light, on the control panel, also causing the alarm bell to ring. When "tripped," the ground relay opens (1) the ER relay, (2) the shunt field contactor, and (3) the battery field contactor; this unloads the main generator. The ground relay must be reset before the unit can again deliver power. The relay is reset by pressing in on the reset button on the relay. Should the relay repeatedly trip when power is applied, the power plant MUST be isolated.

CAUTION: Isolate unit before resetting the ground relay.

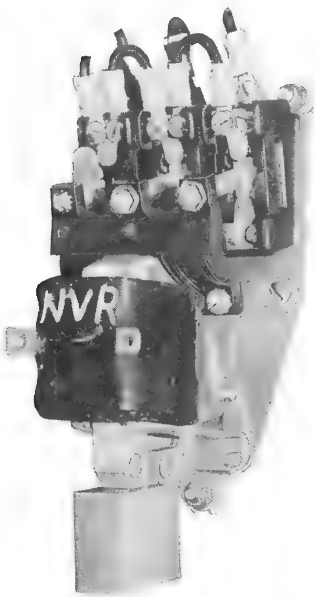
If the ground relay trips, the white needle in the relay will point to a red dot. In the normal position the needle points to a yellow dot.

With ground relay tripped, the speed of the engine will be reduced to idle and will remain at that speed;

unless the throttle is placed in the 5th or 6th notch, in which case the engine will stop.

Although a high voltage ground will normally be the only reason for the ground relay tripping, a low voltage ground can trip the relay when the engine is started; since at that time the high and low voltage systems are temporarily connected. Ground relay action is not necessarily an indication of serious trouble but should be reported to the maintenance authorities.

The ground relay knife switch, when open, eliminates the protection of the ground relay. This switch MUST NOT BE OPENED in normal operation unless definite instructions are issued.



No Voltage Relay
Fig. 3-12

321 NO AC VOLTAGE RELAY (NVR) As the traction motors are cooled by AC driven blowers, failure of the alternator could result in damage to the traction motors unless the application of power was stopped. Thus, in case of an alternator failure, the NVR, Fig. 3-11, located on the distribution panel, drops out and causes the alarm bell to ring in all units. It also turns on a purple light and reduces the engine speed to idle in the unit affected (if the throttle was in the 5th or 6th notch, the engine would stop).

NOTE: An alternator failure indication is usually only the result of an engine being stopped

and not the cause of its stopping. The alternator failure alarm, will not operate when the isolation switch is in the START position.

SECTION 4

COOLING SYSTEM

400 DESCRIPTION OF THE COOLING SYSTEM

Water is drawn from the oil cooler and water tank assembly by two centrifugal pumps mounted on the front end of the engine. Water is pumped to the bottom of each cylinder liner, and from there up through the cored passages of the cylinder and head, to the outlet manifold. From the engine the water flows to two banks of radiator sections (4 radiator sections per bank) located in a hatch at the top front of the engine room hood (a connection from the engine outlet manifold is also made to the two cab heaters). After being cooled in the radiator, the water then returns to the oil cooler and water supply tank, and from there to the suction side of the water pumps.

Cooling air is drawn in through the two openings on either side of the hood at the front of the locomotive by the four engine cooling fans. The four AC driven cooling fans are located below the radiator sections (two fans per bank) and blow the cooling air up through the radiators, the air being discharged from the locomotive at the top of the hood. Automatic shutters are located in the top of the hood above the radiators. The shutters open simultaneously with the turning on of the No. 1 fan and close when that fan stops.

With rising temperature, the sequence of operating the fans is 1-3-2-4 according to the sequence shown below:

1. No. 1 fan is turned on at 165°.
2. No. 3 fan is turned on at 168°.
3. No. 2 fan is turned on at 171°.
4. No. 4 fan is turned on at 180°.

With decreasing temperature the fans are individually turned off, 10° below the temperature at which they were turned on.

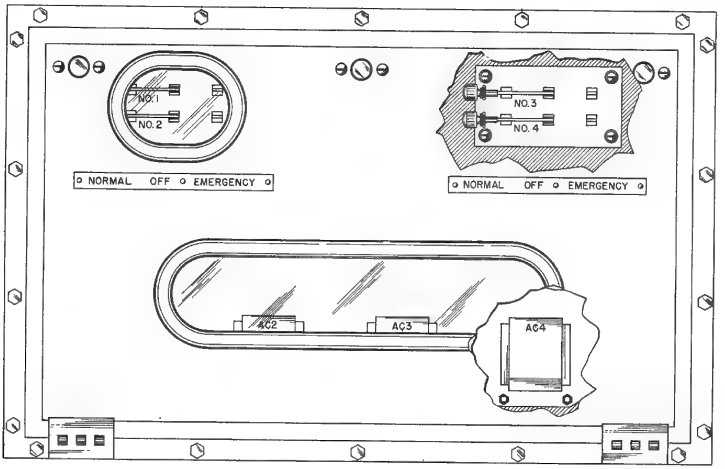
The four cooling fan contactors are located behind a small glass door on the front side of the hood, Fig. 4-1. Behind this same glass door are four single-pole double-throw switches which permit manual operation of the fans, if this becomes necessary. Each switch controls one fan and has three positions which are described below:

a. NORMAL (Left) - Fan is controlled by thermostatic switch.

b. OFF (Center) - Fan is cut out, regardless of thermostat.

c. EMERGENCY (Right) - Fan is cut in, regardless of thermostat.

In case the temperature of the cooling water leaving the engine reaches 208°, the engine temperature alarm



Cooling Fan Control Panel
Fig. 4-1

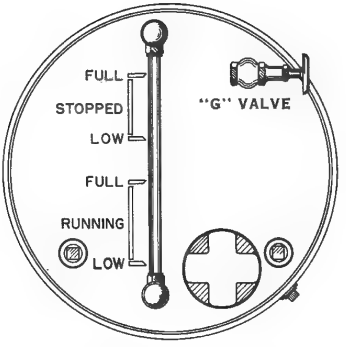
switch will close; this will cause the Hot Engine alarm light (RED) to be lit and the alarm bell to ring in the cab.

401 OPERATING WATER LEVEL Operating water levels are stenciled on the cooling water supply tank, next to the water level gauge glass, Fig. 4-2. Minimum and maximum water levels are indicated with the engine running and stopped. The engine should never be operated with the water below the low water level. Progressive lowering of the water in the gauge glass indicates a leak in the system and should be reported.

The cooling system is filled either through the filler-vent pipe located on the roof of the locomotive above the water tank or through the filler pipes at the front of the locomotive, on either side.

To fill the system proceed as follows:

1. Stop engine.
2. Open filling level valve "G."
3. Fill slowly until water runs out filling level pipe at valve "G."
4. Close "G" valve.



Cooling Water Tank
Fig. 4-2

If filling a dry or nearly dry engine also follow these additional steps:

5. Start engine and run several minutes. This will eliminate any air pockets in the system.
6. Shut down engine and open "G" valve.
7. Add water until it runs out filling level pipe.
8. Close "G" valve.

If the cooling system of hot engine has been drained, do not refill immediately with cold water. If this is done, the sudden change in temperature might crack or warp the cylinder liners and heads.

CAUTION: 1. Do not attempt to fill the cooling system through the drain pipe located underneath the locomotive.

2. The system should not be filled above the maximum water level indicated on the water tank, to prevent the loss of rust inhibitor or anti-freeze when draining back to "G" valve level.

SECTION 5

LUBRICATING OIL SYSTEM

Oil under pressure is forced through the engine for lubrication and piston cooling by the combination piston cooling and lube oil pump. Lube oil which falls into the oil pan is picked up by the scavenging oil pump and forced through the oil filters and cooler to the oil strainer housing where it is ready for recirculation by the oil pump. The excess returns to the oil pan.

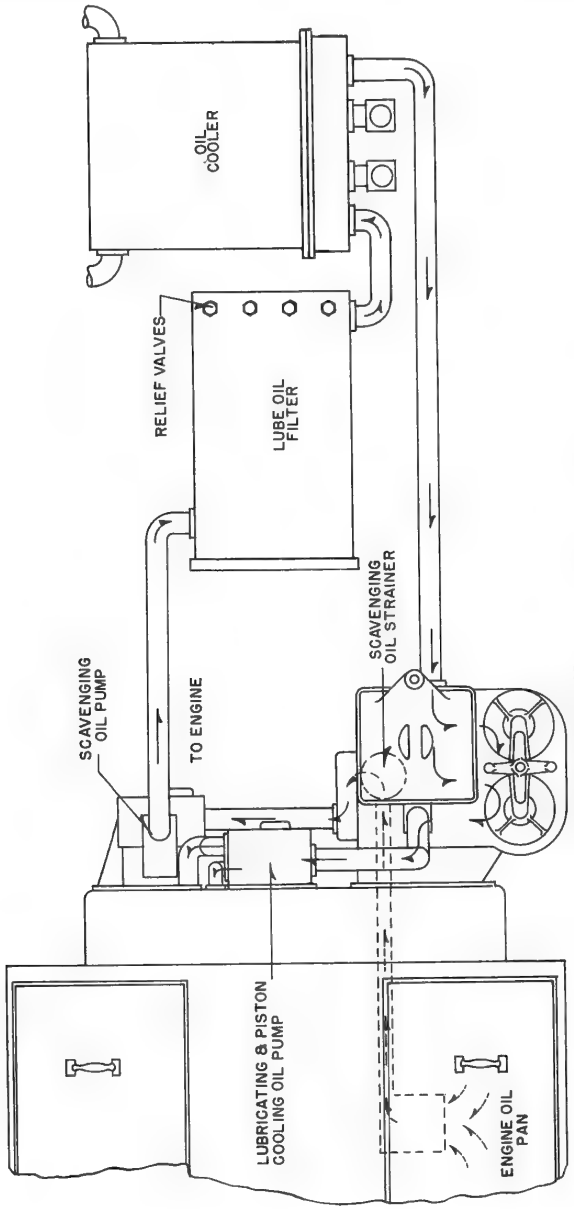
500 OIL LEVEL The oil level may be checked with the engine running at idle speed (hot oil) and should read between "low" and "full." A bayonet type dipstick, Fig. 5-1, is located on either side of the engine.

Oil "Dip-Stick"
Fig. 5-1

501 ADDING OIL TO SYSTEM When oil is added to the system, it must be poured through the opening having the square cap on top of the strainer housing. Should the round caps be removed while the engine is running, hot oil under pressure will come from the openings and possibly cause personal injury.

When the engine is stopped, all the oil in the cooler core chamber will drain into the strainer chamber and then overflow into the engine oil pan, which will bring the engine oil pan bayonet gauge reading above the "Running - Full" mark.

502 OIL PRESSURE Oil pressure at 800 RPM is normally 35 to 45 pounds. It should not drop below 20 pounds. At idle the pressure should be at least 6 pounds (in the event of dangerously low oil pressure the engine will automatically be stopped).



Lubricating Oil System Schematic
Fig. 5-2

SECTION 6

FUEL OIL SYSTEM

600 DESCRIPTION OF FUEL FLOW The fuel pump and dual fuel filter are located in a small cabinet near the front left side of the engine. This cabinet is used to aid in warming the fuel in cold weather but should be opened in warm weather.

Fuel is drawn from the storage tank, under the locomotive, through the suction side of the dual fuel filter to the motor driven fuel pump. From the pump the fuel is forced consecutively through the pressure side of the dual fuel filter and the twin element sintered bronze filter, mounted on the right front end of the engine. After passing through the sintered bronze filter the fuel flows to the injectors. The excess fuel not used by the injectors passes through a restricting orifice and return fuel sight glass, located on the sintered bronze filter; the return fuel then branches off in two directions to fill the hot water heater day tanks located at each end of the locomotive. When the day tanks are filled, the fuel overflows through a pipe that returns the fuel to the main storage tank, see Chart 5.

A 15# differential pressure relief valve is installed on the pressure side of the dual fuel filter. This relief valve permits fuel to be by-passed to the duplex sintered bronze filter on the engine if the element in the pressure side of the dual filter becomes clogged.

The sintered bronze filter is provided with a 45# relief valve which will open and by-pass fuel around the engine to the fuel return line, in case the sintered bronze elements are dirty or if the fuel manifold lines are clogged (as may be the case when starting the fuel pump in severe cold weather). In case the 45# relief valve opens, for any reason, it will be indicated by the presence of fuel in the by-pass sight glass.

601 FILLING FUEL TANK The fuel tank is properly vented and equipped with a spark arrestor. Fuel fillers are provided on each side of the tank so that the tank may be filled from either side of the locomotive. Two direct reading full length sight level gauges are located on each side of the fuel tank. These gauges are used while filling the fuel tank to prevent overflowing and for approximating the amount of fuel remaining in the tank. The fuel should be filtered through a reliable fuel filter before it enters the tank. DO NOT HANDLE FUEL OIL NEAR AN OPEN FLAME.

602 EMERGENCY FUEL CUTOFF VALVE An emergency fuel cutoff valve is provided in the fuel suction line between the fuel tank and engine fuel pump, to cut off the supply of fuel to the pump in case of fire or an emergency; a second emergency fuel cutoff valve is located in the steam generator fuel suction line, for the same purpose.

On each side of the locomotive a small box with a lift cover is attached to the locomotive frame. Enclosed in the box is a pull ring which is attached to a cable running to the fuel cutoff valves. A similar pull ring is located in the cab near the controller. The fuel cutoff valves are both tripped at the same time by pulling any one of the pull rings. When the cutoff valves are tripped, the entire fuel supply from the tank is interrupted. Once the cutoff valves are tripped they will have to be reset manually before normal operation can be resumed.

The emergency fuel cutoff valves are located inside the engineroom hood, near the right rear end of the engine, just below the level of the catwalk. To reset: pull each valve stem up so that the yoke, which normally holds the valve open (valve stem up), may be slid into place, Fig. 10-23.

SECTION 7

AIR SYSTEM

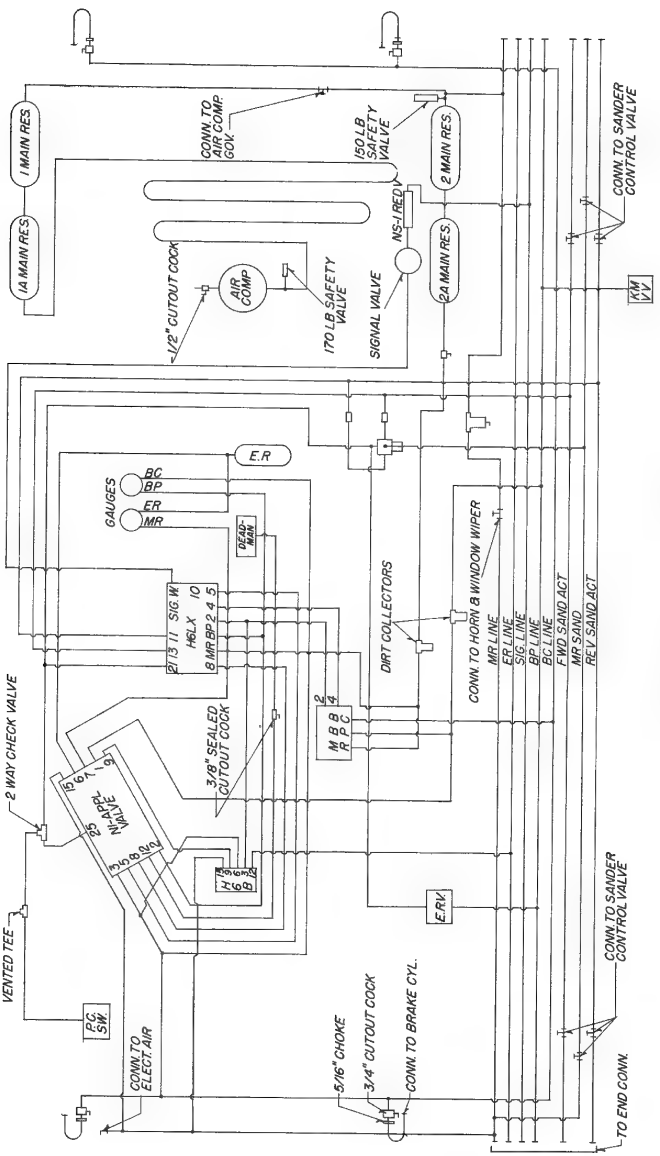
Compressed air is not only used on a Diesel locomotive for operating the air brakes and sanders, but is also essential for the proper operation of many other items. The reverser, shunting contactor, shutter operating cylinders, horn, bell and windshield wipers are also air operated. A schematic drawing of the air piping arrangement is shown in Fig. 7-1.

700 AIR COMPRESSOR Each locomotive power plant is equipped with an air cooled 3-cylinder, two-stage air compressor. The compressor is driven through a flexible coupling from the armature shaft of the main generator.

The compressor has its own oil pump and pressure lubricating system. With the engine stopped the level in the compressor crankcase can be checked on the bayonet type gauge. Lubricating oil pressure should be a minimum of 10 pounds at idle speed (275 RPM).

The compressor consists of two low pressure cylinders and one high pressure cylinder. The pistons of all three cylinders are driven by a common crankshaft. The two low pressure cylinders are set at an angle to the vertical high pressure cylinder. Air from the low pressure cylinder goes to an intercooler, or radiator, to be cooled before entering the high pressure cylinder. The intercooler is provided with a pressure gauge and relief valve. The gauge normally reads approximately 34 pounds when the compressor is loaded. The intercooler relief valve is set for 55 pounds. Any marked deviation of intercooler pressure from 34 pounds should be reported to the maintenance terminal.

Condensation and oil collects in the sump of the bottom header of the compressor intercooler and should be drained once at each crew change and at the regular



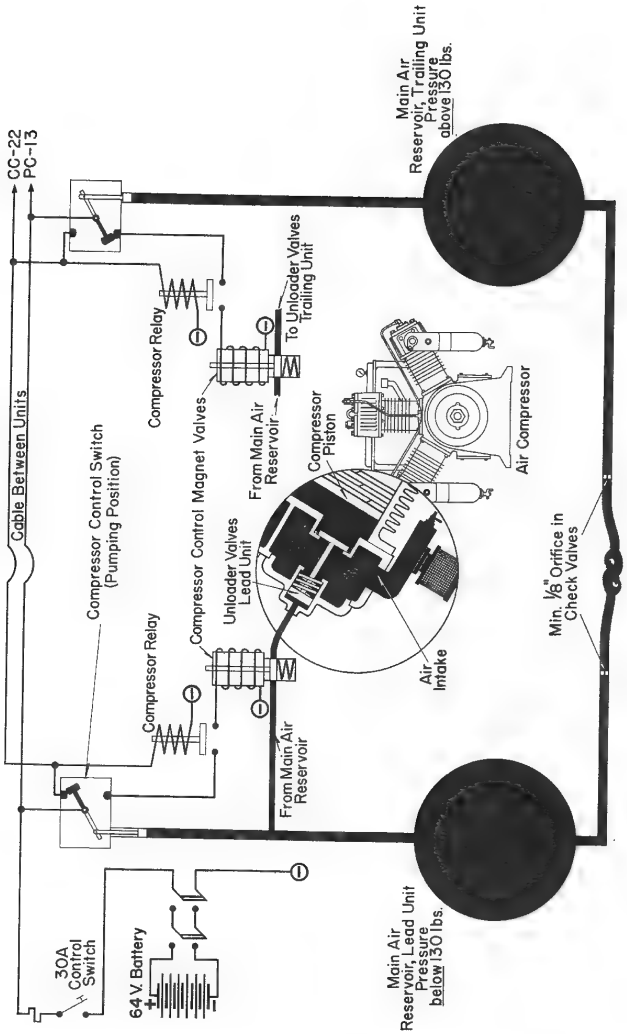
Schematic Air Piping
Fig. 7-1

maintenance period. Two drain valves are provided in the sump for this purpose. Operate the intercooler safety valve by hand, when draining the intercooler, to be certain that it functions properly.

Since the air compressor is directly connected to the engine and is in operation at all times when the engine is running, an unloader is provided in the heads of both high and low pressure cylinders which cuts out the compressing action when actuated by air pressure. The unloader accomplishes this by blocking open the suction, or intake, valves of the high and low pressure cylinders. When the air operating the unloader is cut off, the unloader releases the suction valves and the compressor resumes pumping. Air pressure from the main air reservoir actuates the unloader valves.

701 COMPRESSOR CONTROL A schematic of the compressor control system is shown in Fig. 7-2. The loading and unloading of the compressor in each unit is controlled by an electro-pneumatic system. The electrical arrangement is such that all compressors in the locomotive are synchronized to pump air into their respective main reservoirs when the main reservoir air pressure in any one unit drops to 130 pounds. When the air pressure in all main reservoirs reaches 140 pounds, the compressors will unload. Each unit is equipped with a compressor control switch (CCS) actuated by main reservoir pressure and a compressor relay (CR). A compressor control wire (CC) runs throughout the locomotive and connects the compressor relays in each unit in parallel.

The compressor control switch is located on the right side of the plumbing stack above the lube oil filter cover. This switch may be considered to be a single-pole double-throw switch that is thrown to the "loaded" position when the main reservoir pressure drops to 130 pounds, or to the "unloaded" position when the main reservoir pressure reaches 140 pounds. In the unloaded position the CCS causes the compressor



Air Compressor Control Schematic
Fig. 7-2

control magnet valve, CC, to be energized, allowing air to pass through the valve to the compressor unloader pistons. In the loaded position the CCS breaks the circuit to compressor control magnet valve in that unit and causes current to flow through the CC wire energizing the CR relays in each unit. When the CR relay is energized its interlock breaks the circuit to the compressor control magnet valve regardless of the position of the CCS in that unit.

702 AIR COMPRESSOR MANUAL UNLOADER VALVE

A three-way valve is provided in case it is desired to keep an air compressor unloaded, irrespective of the compressor control system. Normally the valve handle is in a vertical position; turning the handle to a horizontal position causes the compressor to remain unloaded, see Fig. 10-26.

703 DRAINING OF AIR SYSTEM The air system should be drained periodically to prevent moisture from being carried into the air brake and electrical control air systems. The frequency of draining will depend on local conditions and can be determined by practice. It is recommended that draining be done at the time of each crew change, until a definite schedule can be determined.

NOTES

SECTION 8

COLD WEATHER STARTING

800 GENERAL A winterization system is built into the locomotive, a schematic arrangement of which is shown in Chart 5. This system has been included to permit the initial warming of the cooling, lubricating and fuel oil systems, following an extended layover, in severe cold weather, prior to starting the engine. With reference to Chart 5, the best description of the system will be obtained from the operating instructions given in Article 801.

As will be shown, the winterization system has been designed to enable starting the engine under winter conditions that may have been cold enough to congeal the lubricating oil and fuel oil. It will be assumed that the engine cooling system is filled with an adequate anti-freeze solution or was drained completely.

801 OPERATION OF THE WINTERIZATION SYSTEM When the engine was last stopped, the heater fuel tanks were automatically left completely full; each tank contains approximately 4 gallons of fuel which is sufficient to operate each heater about 2-1/4 hours.

The battery may always be said to be the "weakest link in the chain" of starting the engine; this is especially true in sub-zero weather. Every effort must be made to get the most out of the battery for a given state of charge and to expend that energy to the best advantage. A warm battery will greatly facilitate the starting of a cold engine.

NOTE: For the successful operation of lead-acid storage batteries in severe cold weather it is necessary to KEEP THE BATTERY FULLY CHARGED AT ALL TIMES; even if this necessitates a slight

overcharge with resultant gassing and frequent adding of water. The specific gravity of the electrolyte should be maintained between 1.250 and 1.275 in order to keep the battery from freezing.

Since the battery can be counted on to perform the pre-warming and starting procedure but once, the sequence of steps taken to accomplish this must be followed exactly and completely as shown in the following outline:

1. Close the main battery knife switch in the electrical cabinet. All other switches should be open or off, and the isolation switch in the Start position.

2. Place the main switch of the No. 2 heater, Fig. 8-2, in the Electric Heater position; this will turn on the electric-immersion heating unit in the No. 2 heater fuel tank.

3. After the fuel in the No. 2 fuel tank has been warmed for 10 minutes, start the No. 2 "hot water" heater (these instructions are given in detail in Article 803). When starting the heater, the exhaust stack damper must be manually held in the OPEN position until the heater is firing properly. When the damper is released it will close and cause the heater exhaust gases to be diverted so they will pass through the battery box on the right side of the locomotive. This is done in order to heat the batteries; a thermostat will cause the exhaust stack damper to open if the temperature of the batteries should get too hot.

   When the hot water heater main switch is moved to the Burner position, the immersion heating elements are automatically turned off.

The No. 2 "hot water" heater circulates a low-freezing temperature liquid through a warming pipe which passes through the main fuel tank, around the engine fuel oil filters and engine fuel pump, and then passes through the engine lubricating oil sump, before returning back to the heater.

4. Continue operation of the No. 2 "hot water" heater until the temperature of the circulating pump is above the freezing point of water; this will be indicated by (a) the disappearance of frost on the pump or (b) "spitting" on the pump to see if saliva freezes or not.

When the circulating pump is above the freezing point of water, it is time to make an attempt to start the main fuel pump, which is located in an insulated box near the left front end of the engine. This is done as follows:

a. Turn ON, or close, the control knife switch and fuel pump circuit breaker, both of which are located in the electrical cabinet.

b. Turn ON the control and fuel pump circuit breakers at the control panel.

If the fuel pump circuit breaker in the electrical cabinet "kicks out" it is an indication that the fuel is still too cold to be pumped. In this case allow an interval of time for the heater to more adequately heat the fuel before again attempting to start the fuel pump; reset the fuel pump circuit breaker by placing it in the full OFF position, and turn OFF the control circuit breaker on the control panel. Since the heater fuel tanks must be replenished by use of the main fuel pump, it is most important to get this pump running before the fuel supply for the No. 2 heater is depleted.

When the fuel pump first continues to run steadily, fuel will generally appear first in the by-pass fuel sight glass, located on the right front corner of the engine (there are two sight glasses here; the by-pass sight glass is the one farthest from the engine). If fuel should flow through the return sight glass (the one nearest the engine), so much the better. Fuel flow through either sight glass is the immediate objective, as a flow of fuel through either glass will cause the No. 2 heater fuel tank to be replenished.

5. Once the fuel pump is running satisfactorily (as indicated by the fuel pump circuit breaker "staying in," and the presence of fuel in either or both fuel sight glasses) it is time to begin warming the "jackets" of the engine. This is done by starting the No. 1 "hot water" heater, while continuing the operation of the No. 2 heater and main fuel pump.

   If the engine cooling system is filled with an anti-freeze solution, the same instructions used in starting the No. 2 heater are to be followed in starting the No. 1 heater; that is, the electric immersion heating unit must be turned ON for 10 minutes before following the standard instructions for starting the heater.

NOTE: On locomotives that do not have steam generators, the entire battery is located in the "steam generator" compartment and is warmed with only the exhaust gas of the No. 2 heater; if this is the case, the No. 1 heater will not be equipped with a manual and thermostatically controlled exhaust stack damper.

If the engine cooling system has been drained and is to be refilled with WATER, it must enter the

engine Cold Weather Fill Valve (this valve is located behind a small door on the left hand side of the locomotive hood near the No. 1 "hot water heater"). Water should be emitted into the engine cooling system in this manner IMMEDIATELY AND ONLY AFTER THE NO. 1 HEATER HAS BEEN STARTED; the cooling system drain valve is to be open until the water, passing through the heater, and out the drain valve, is noticeably warm.

NOTE: If the temperature is such that water can be handled up to the point of entry in the engine (through the cold weather fill-valve) it can be used satisfactorily; otherwise a satisfactory anti-freeze solution must be used.

A satisfactory anti-freeze solution can, of course, be introduced to the engine through any of the normal filling lines prior to starting the No. 1 heater.

After the cooling system has been filled to "G" valve level, continue the operation of the Numbers 1 and 2 "hot water" heaters and fuel pump until the engine, engine room and associated piping are comfortably warm. This point will generally be indicated by two items:

a. The disappearance of fuel in the by-pass sight glass with its appearance in ONLY the return fuel sight glass.

b. The disappearance of frost on the circulating pump of the No. 1 heater.

NOTE: If the foregoing operation required several hours to reach the point where there is no frost on the circulating pump of the No. 1 heater, and it appears doubtful that a higher temperature will be reached, an attempt should be made to start the engine.

If however, the warm-up process proceeded quickly (as in the case of a low wind velocity), a further delay until the circulating pump of the No. 1 heater is warm to the naked hand will be distinctly beneficial to the battery, engine, air compressor and other parts of the locomotive.

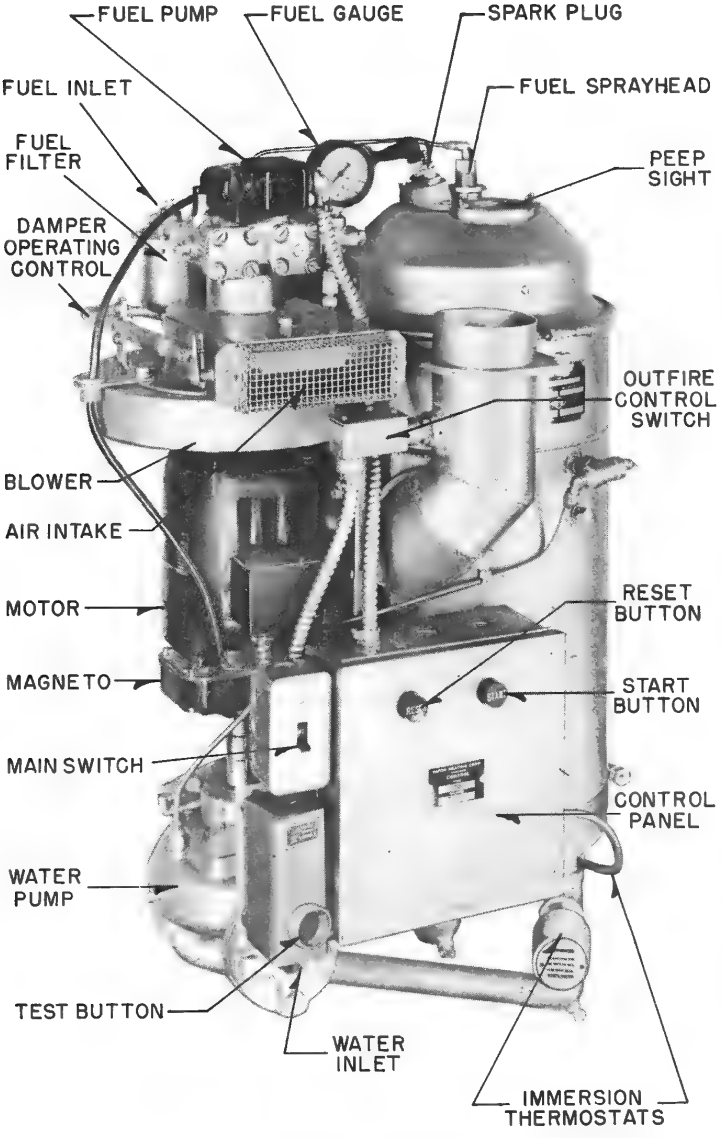
It should be borne in mind that at very low temperatures, a storage battery contains but one attempt to start the engine. Any attempt to start the engine before it and its associated piping are brought up to the highest possible temperature, may result in the necessity of replacing the exhausted battery before another attempt to start the engine can be made.

6. After the engine and associated piping have been brought up to the highest possible temperature, follow the instructions for normally starting the engine, as given in Articles 201 and 202.

7. With the engine running, the No. 2 heater is to be kept in operation. However, it is no longer necessary to continue operating the No. 1 heater, and it is turned off by merely placing the heater main switch in the OFF position. If desired, the No. 1 heater may be allowed to continue operation until the cab heaters are noticeably warm.

802 DESCRIPTION OF HEATER The operation of the model DH-4915 hot water heater is completely automatic after it has been started. The motor runs continuously while the burner cycles on and off.

The heater part of the unit consists of two water jackets connected in series. Water is pumped into the outer water jacket and then through the inner water jacket. Heat is furnished by the combustion of diesel



DH-4915-3 Heater
Fig. 8-1

fuel oil, which is sprayed through the fuel sprayhead into the fire pot. Here the fine oil spray mixes with air supplied by the blower and is ignited by a continuous electric spark. The hot gases flow past the inner surface of the inner water jacket and then around to wipe over the outer surface of the inner water jacket and the inner surface of the outer water jacket.

A single electric motor drives the blower fan, fuel pump and the water circulating pump. An immersion thermostat keeps the water temperature returning to the heater within its control range of 110° to 130°.

The output rating of the heater is 150,000 BTU's per hour. The fuel consumption is 1.65 gallons per hour at maximum output.

803 HEATER OPERATING INSTRUCTIONS

NOTE: Do not start heater unless system is completely filled with water.

To Start

1. Place main switch in Burner (up) position.

The motor will start and circulate the water and the combustion air. The fuel will be by-passed back to the supply tank through the fuel pump by the action of the fuel solenoid valve.

2. Rotate the fuel filter handle at least one revolution clockwise.

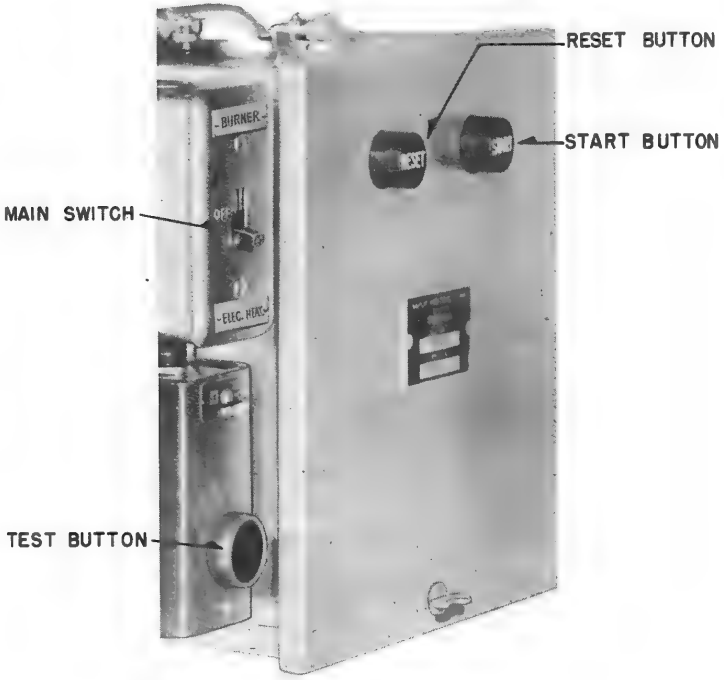
3. Press the start button. This puts the control circuit in operation. The fire will start, unless the water temperature is over the range for which the aquastat is adjusted. If the heater

should fail to fire, the outfire control will shut the burner down in approximately 45 seconds. Wait 2 minutes and depress the start button again. If unit still fails to fire, check the trouble shooting section.

On the DH type unit if the fire fails to light, it is possible to check the operation by holding the test button down, which over-rides the immersion thermostat and the unit will fire.

To Stop

Place the main switch in the OFF position.



DH Type Control Panel
Fig. 8-2

RUNNING ATTENTION

1. Fuel pressure should read 100 lbs. on the gauge, when unit is firing.
2. If a rectifier is used, check the charge rate lamp for burning.
3. Check damper to see that it is properly adjusted.

804 TROUBLE SHOOTING

1. If motor is running, there is no fire and the temperature of the water is below 120° (so that the aquastat or immersion thermostat is calling for heat), check:

   a. If there is fuel pressure: (Should be 100 lbs. on gauge).

      (1) See that the nozzle is clean and produces an even spray pattern.

      (2) See that there is sufficient spark at the electrodes, gap should be 1/8 inch. Lack of spark may be due to the magneto contacts not opening properly, they should be set at .018 inch.

      (3) See that the electrodes are just out of spray pattern.

      (4) See that the spray pattern has approximately 1/4 inch inside clearance all around the stabilizing cone.

      (5) See that the damper is properly adjusted.

      (6) See that the aquastat or immersion thermostat is calling for heat.

   b. If there is no fuel pressure:

(1) Fuel tank may be empty.

(2) Check fuel flow through bleeder valve under gauge (bottom side of tee - use Allen wrench).

(3) Check operation of fuel solenoid valve.

(4) Check fuel pump coupling by removing the inspection cover on air duct.

(5) Check for fuel suction leak in line.

2. If motor does not run:

a. See that the motor overload reset is made.

b. Check both fuses.

c. Check power supply to unit.

NOTE: If trouble continues check the alignment between fuel pump and water pump and between oil pump and water pump.

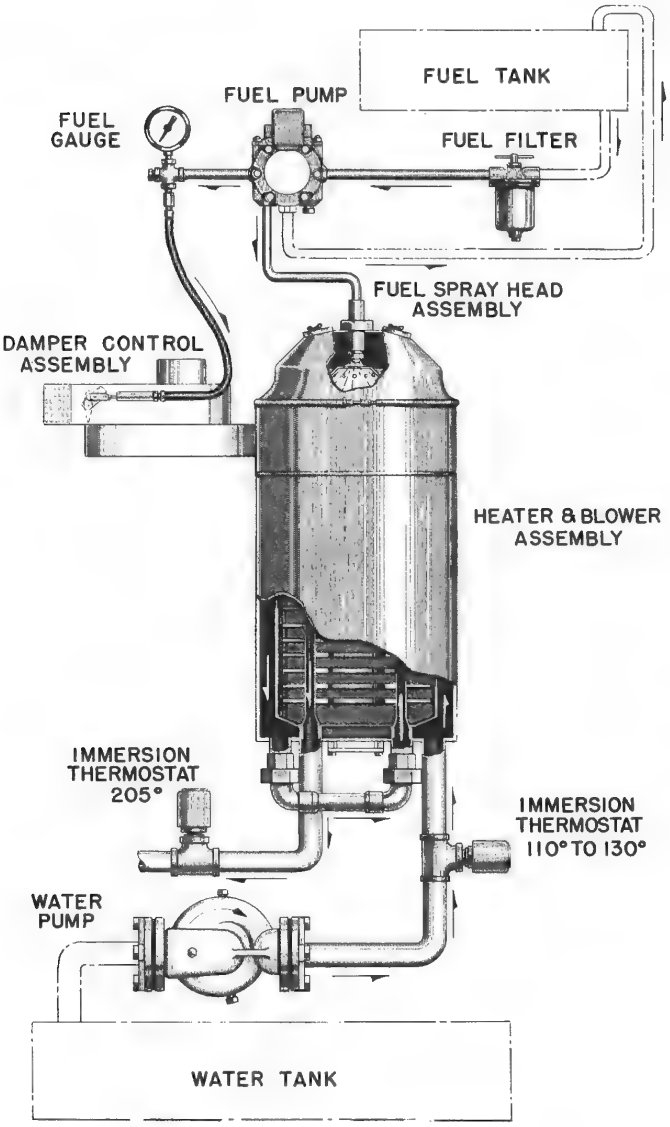
3. A rapid rise in the temperature may be caused by air in the water system causing poor circulation. Bleed the air from the water system through the plug or pet cock located on top of the heater near the water outlet, or else on water pump whichever is higher. Be sure that the water circulating pump is operating.

805 MAINTENANCE - QUARTERLY INSPECTION - 300 HOURS

1. Examine magneto breaker contacts for burning and set the contact point to .018 inch.

2. Apply sparingly a small amount of No. 106, 115-47 grease to the magneto cam.

3. Clean and check the setting of the spark plug electrodes (should be 1/8 inch).



4915 Schematic Piping Diagram
Fig. 8-3

4. Examine drive motor - check brushes for length and inspect the commutator.
5. Add oil to water pump, until oil overflows from small vent hole.
6. Check outfire relay timing (between 40-50 seconds).
7. Examine the combustion chamber and flue for excessive sooting.
8. Clean fuel suction filter, be sure to bleed the air from the fuel system after cleaning.
9. Clean fuel spray nozzle and strainer.

NOTES

SECTION 9

STEAM GENERATOR
OK-4625

INTRODUCTION

The instructions contained in this section are for the guidance of personnel engaged in the operation of Model OK-4625 steam generators. A general description of the steam generator is given, the operating technique is outlined and a trouble shooting section is provided for the operator.

The symbol number after each device mentioned in the text refers to the schematic operating chart at the end of this section. The numbers are used to facilitate identification of the various devices.

The chart shows the various controls and devices on the OK-4625 steam generator and outlines the flow of fuel, water and steam.

DESCRIPTION

The 4625 steam generators have a maximum rated evaporative capacity of 2750 pounds per hour. Operation is completely automatic after the steam generator is started, and full operating steam pressure is reached within a few minutes.

The steam generating part of the unit consists of three sets of coiled water tubing, nested and connected in series to form a single tube several hundred feet long. Feed water, after passing through the heat exchanger, goes through the economizer coil and from there to the main coils of the steam generator. As the water progresses through the coils it is converted

into steam. Heat is furnished by the combustion of diesel fuel oil, which is sprayed by compressed air through the atomizing nozzle in the fuel spray head-105 into the firepot above the coils. Here the fine oil spray mixes with air supplied by the blower-202, and is ignited by a continuous electric spark-220. The hot gases flow, first downward, then up and outward through the nest of coils, finally flowing out the stack.

OK-4625 Steam Generator
Fig. 9-1

The supply of fuel is regulated to evaporate 90% to 95% of the water pumped through the coils. The excess water flushes scale and sludge from the coils and is carried over with the steam into the steam separator-221, where the water and sludge are removed before the steam flows into the trainline.

The excess water collects in the bottom of the steam separator. Water above the level of the return outlet flows out through a steam trap-223 and through the heat exchanger-213, where it gives up its heat to the incoming feed water. From the heat exchanger the return water flows through the return water flow indicator-218 back to the water supply tank-232.

The motor converter-215 drives the blower-202, water pump-230 and fuel pump-209 at a constant speed. The water by-pass regulator-111 automatically controls steam generator output by regulating the amount of water fed to the coils. Before entering the coils, the water passes through servo-fuel control-108, which admits fuel to the spray nozzle in direct proportion to the amount of water entering the coils. The servo-fuel control also adjusts the damper-203 to admit the proper amount of air for efficient combustion of the fuel.

The trainline steam pressure is regulated by adjusting the setting of water by-pass regulator-111. The length of train and weather conditions determine setting.

BEFORE STARTING

The valves designated by odd numbers must be OPEN during normal operation of the steam generator. Valves designated by even numbers must be CLOSED during normal operation of the steam generator. Normally open valves are fitted with a cross type handle; normally closed valves are fitted with the standard round handle.

1. Make certain that the following valves are OPEN:

   Atomizing Air Shutoff Valve-1
   Coil Shutoff Valve-3
   Return Water Outlet Valve-9
   Trainline Cross-Over Valve-11
   Steam Admission Valve-13 to Water By-Pass Regulator-111
   Three-Way Washout Valve-17
   Water By-Pass Regulator Shutoff Valve-19
   Water Supply Stop Valve-21

2. Be sure that the following valves are CLOSED:

   Coil Blowdown Valve-2
   Layover Connection Shutoff Valve-6
   Manual Water By-Pass Valve-8
   Steam Admission Valve-10 to Radiation-217
   Washout Inlet Valves-14 and 16
   Water Pump Test Valve-18
   Water Drain Valves-20 and 22

3. See that both the overload reset button-106 and the stack switch-109 reset button are "In." The overload reset button is located inside the control panel on the magnetic overload relay.

TO FILL

1. Open the atomizing air shutoff valve-1 and fill-test valve-4; latch open the separator blowdown valve-12 to drain steam separator. Close the separator blowdown valve when separator is completely drained.

2. Close the main switch and turn the control switch-102 to FILL.

3. While the coils are filling see that spark-220 is available for ignition. Check ALL valves.

4. When water discharges from the fill-test valve-4 turn the control switch-102 to OFF and close the fill-test valve.

CAUTION: The water pump, being a high pressure pump is liable to apply an undesirable hydrostatic test to the steam generator, gauges and controls, unless the control switch is immediately placed in the "Off" position when water discharges from the fill-test valve.

NOTE: If the coils are empty it will take about five minutes to fill the steam generator with water.

TO START

CAUTION: Do not start the steam generator unless the coils are filled.

1. Latch open the separator blowdown valve-12 and turn the control switch-102 to RUN. For easy starting, be sure the control switch has been OFF long enough for the motor to come to a full stop.
2. Close the separator blowdown valve when the generator steam pressure gauge-212 registers approximately 150 pounds.
3. OPEN THE SEPARATOR BLOWDOWN VALVE SEVERAL TIMES FOR THREE TO FIVE SECOND INTERVALS DURING THE FIRST FEW MINUTES OF OPERATION.
4. Set the water by-pass regulator-111 to the required trainline pressure.
5. After coupling trainline, open remote control trainline shutoff valve-7, by depressing reset lever-7a. Then open trainline stop valve-15.

NOTES:

1. Check the return water flow after the steam generator has settled down to a steady output. On 2750 pound units it should cycle from 4 to 10 times a minute.

2. If the steam generator does not start or function properly, check all valves to see that they are open or closed as indicated in the operation chart.
3. The steam generator should come up to full operating pressure in one or two minutes; it may take 10 to 15 minutes to build up the required operating steam pressure in the trainline.

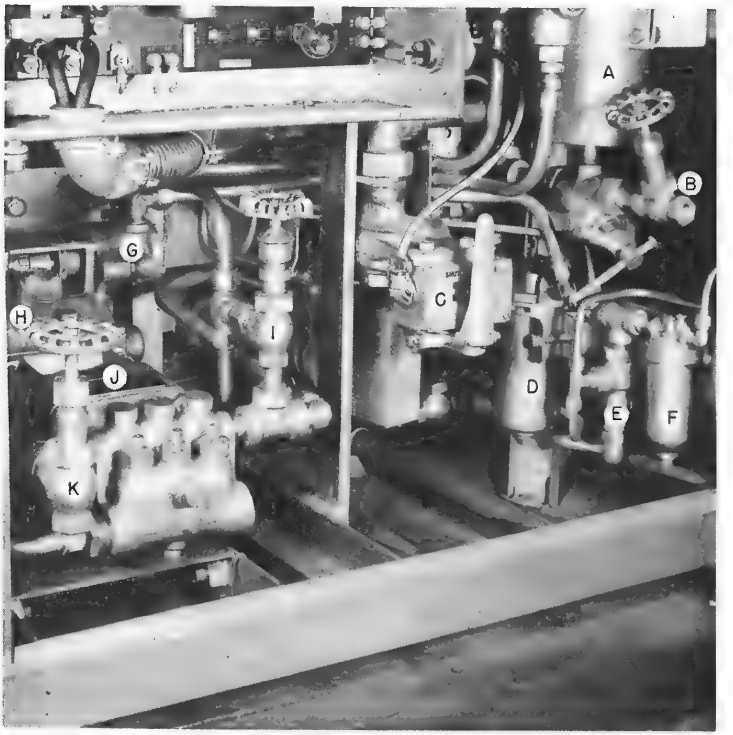
RUNNING ATTENTION

1. Open separator blowdown valve-12 for 2-3 seconds approximately every 1/2 hour. Frequent blowdowns will reduce the tendency for sludge to accumulate.
2. Turn the handle on the fuel filter-206 during stops. At the same time, turn the handle on the treatment injector filter-225, where this method is used.

TO SHUT DOWN STEAM GENERATOR

For short stops it is only necessary to close the stop and check valve-15. The fire will cycle and maintain operating pressure in the steam generator. For terminal stops, proceed as follows:

1. Press trainline shutoff switch on remote control panel and close stop valve-15.
2. Set the water by-pass regulator-111 to maximum output. When the generator steam pressure gauge-212 registers 200 pounds turn the control switch-102 to OFF.
3. Open the coil blowdown valve-2. When the generator pressure drops to 100 pounds close the valve.
4. Open the separator blowdown valve-12 and blow down the steam separator-221 with the remaining pressure.
5. Fill the coils with water according to the procedure given on Page 903, with the exception that it will



A. Steam Trap-223
B. Fill Test Valve-4
C. Coil Blowdown Valve-2
D. Fuel Filter (Suction)-206
E. Fuel Pressure Regulator-103
F. Fuel Filter (Pressure)-204
G. Fuel Pump-209
H. Water Pump Crankcase Filler Pipe-216. Bayonet Type Oil Gauge To The Right Of Filler Pipe, Just Visible Over Valve Handle
I. Manual Water By-Pass Valve-8
J. Water Pump-230
K. Water Pump Test Valve-18

Lower Section Of Control Cabinet
Fig. 9-2

be found advantageous to fill a "hot" steam generator with the separator blowdown valve latched open, thereby purging the coils while also eliminating the discharge of obnoxious steam within the compartment.

6. Close the atomizing air shutoff valve-1 and open the main switch.

NOTE: When starting, do not omit draining the steam separator, opening the fill-test valve, and again filling the steam generator with water. If coils are already full, it will only take a moment for water to discharge from fill-test valve.

FREEZING WEATHER PRECAUTIONS

The inlet valve-10 to the radiation-217 and the water supply stop valve-21 should be opened when operating during severe weather. The inlet valve-10 controls the entire protective heating system, see Fig. 9-5.

If a locomotive with a multiple installation does not have all of its steam generators in operation, open the layover connection shutoff valve-6 and the inlet valve-10 to the radiation on idle steam generators.

CAUTION: Trainline remote control valve-7 and/or trainline stop valve-15 must be closed when shutting off steam to the trainline.

If a locomotive is left standing out of service, operate one of the steam generators or make a connection to the yard steam line. In extremely cold weather the water pump-230 and steam generator controls should be given additional protection against freezing.

If no steam at all is available, thoroughly drain the steam generator. Open the drain valves-20 and 22, the water pump test valve-18, the coil blowdown valve-2,

the separator blowdown valve-12 and the coil shutoff valve-3. Break the pipe connections where necessary to completely drain the piping. Turn the water pump by hand to clear it of water, or blow it out with compressed air. Remove the cover of the water treatment or water strainer tank-234 and make sure it is drained.

TROUBLE SHOOTING

If one of the protective switches (magnetic overload relay, coil blowdown valve switch, stack switch high temperature contacts or low temperature contacts) operates to shut down the steam generator, the alarm will ring and the "boiler off" signal will flash on the instrument panel.

Turn the control switch-102 to OFF and use the following instructions as a guide in locating the trouble.

Motor And Burner Shut Down During Operation

1. Blown fuses: The alarm will not ring and the instrument lights will go out. The main fuse (100 amp.) is located in the electrical cabinet of the locomotive. Check this fuse, and check the control fuses in the steam generator control cabinet. A test lamp and fuse clips wired inside the control cabinet may be used to check the fuses.

2. Overload reset button-106 "out:" The alarm will ring; the instrument lights will remain on. Turn the control switch-102 OFF; check for hot blower-202 or water pump-230 bearings and for poorly adjusted pulley belts. Check the setting of the belt tension adjuster. Push the overload reset button "in."

3. Stack switch-109 reset button "out:" The high temperature contacts in the stack switch are open; the

alarm will ring and the instrument lights will remain on. Turn the control switch-102 to OFF; open the separator blowdown valve-12 and drain the steam separator-221. Close the separator blowdown valve, push in the stack switch reset button, refill the coils with water, and then start the steam generator.

4. Coil blowdown valve-2 partially open: The alarm will ring, the instrument lights will remain on. Be sure the locking pin on the coil blowdown valve handle is properly seated in the closed position.

Motor Starts But Burner Does Not

If the fire fails to light, the low temperature contacts on the stack switch-109 will not close and after a 45 second time delay the outfire relay will open the circuit to shut down the steam generator. The alarm will ring and the instrument lights will remain on. Turn the control switch-102 OFF and check the following list for possible causes for the burner failure.

1. Ignition failure: Turn control switch to RUN - no spark visible through the peep hole glass, or spark is of low intensity. If an ignition fuse is blown or if the current flow is broken for any other reason, the ignition circuit will be inoperative. If the spark plug electrodes are dirty or too far apart, or if the electrodes are too close together, the ignition circuit will not operate properly.

   Check the ignition fuses — use the test lamp and clips installed in the control cabinet for that purpose. Tighten loose cable connections and replace chafed or broken wire which may be breaking or grounding the circuit.

2. Low atomizing air pressure-201: The air switch-101 opens and breaks the circuit to the fuel solenoid valve-104, which then stops the flow of fuel to the sprayhead-105.

Be sure the air admission valve is fully open. Clean the strainer screen in the atomizing air line and drain the atomizing air pressure regulator-100. If the low atomizing air pressure persists, tighten the adjusting screw at the top of the air pressure regulator to increase the atomizing pressure.

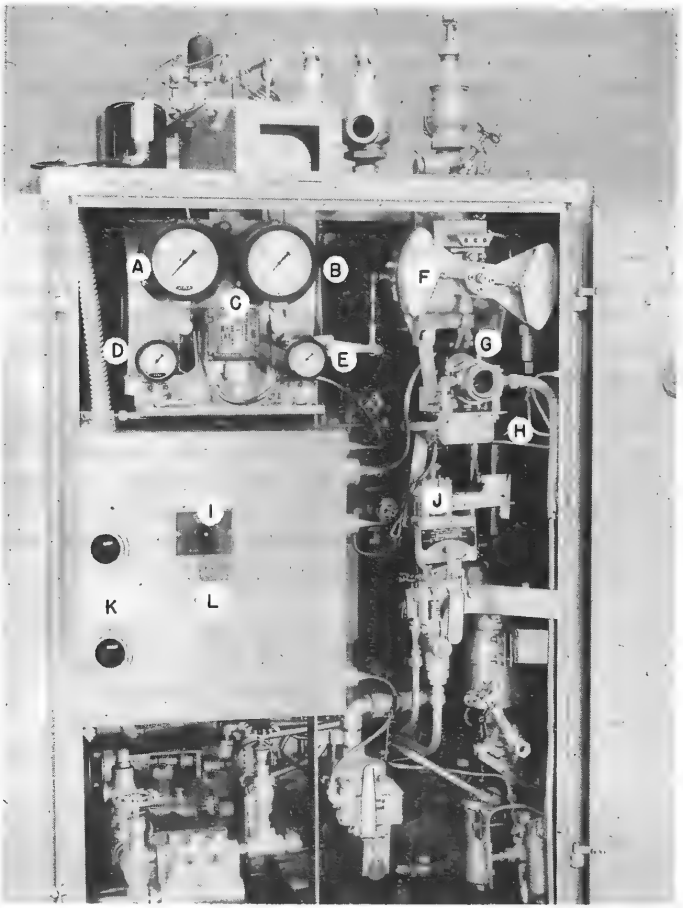
3. Low fuel manifold pressure-208: Turn the handle on the suction line fuel filter-206 several times. A slight suction leak may cause the manifold pressure to build up slowly; put the control switch-102 on FILL to bleed the fuel line and bring the manifold pressure up to normal.

4. Low fuel nozzle pressure-207: Lack of water causes the servo fuel control-108 to limit the supply of fuel entering the nozzle. (If the water supply is almost completely stopped, the cam plate may come down far enough to actuate the cutout switch on the servo and close the fuel solenoid valve-104).

   Be sure that the pump belts have proper tension, the water pump test valve-18 is closed, the cover on the water treatment or strainer tank-234 is tight, the three-way washout valve-17 is fully open, and that the drain valves-20 and 22 are tightly closed.

   Open and close the water by-pass regulator-111 adjusting handle several times to free the regulator from possible sediment. If the water pressure gauge-229 still registers low, close the water by-pass regulator shutoff valve-19. This closes the water by-pass line and permits all of the feed water to flow to the servo-fuel control-108; the steam generator will start at once if the by-pass regulator is causing the trouble. Set and manually regulate the trainline steam pressure by adjusting the manual water by-pass valve-8.

   High feed water temperature or leaky water line connections may cause the water pump-230 to become air or vapor bound. Violent fluctuation of the water



A. Trainline Pressure Gauge-224
B. Steam Generator Pressure Gauge-212
C. Differential Air Pressure Switch
D. Fuel Oil Pressure In Manifold-208
E. Fuel Oil Pressure At Nozzle-207
F. Servo Fuel Control-108
G. Return Water Sight Glass-218
H. Atomizing Air Pressure Regulator-100
I. Control Switch
J. Trainline Pressure Regulator-111
K. Windows For Observing Contactors
L. Overload Relay Reset

Full View Of Control Cabinet
Fig. 9-3

pressure gauge needle indicates this condition. Tighten leaky water line connections and bleed the line by opening the water pump test valve-18. Allow water to flow from this valve until no air or vapor bubbles are evident in the water.

Irregular Trainline Pressure

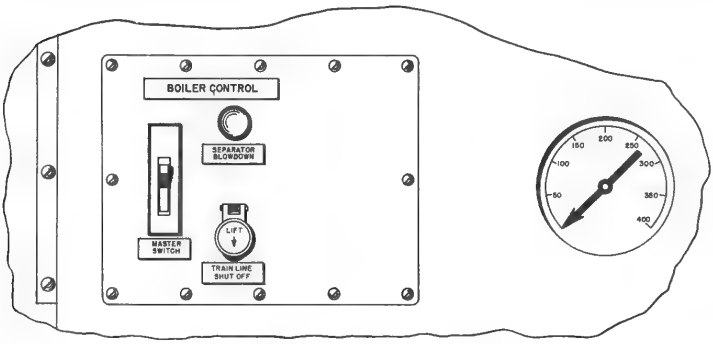
1. Burner cycles off and on: Insufficient water delivery causes the steam generator to run in superheat; the steam temperature limit control-110 operates to protect the coils against overheating. Check the water pump output as instructed in the preceding paragraphs.

2. Safety valves blow: Shut down the steam generator. Lower the trainline pressure setting on the adjusting handle of the water by-pass regulator-111 and start the steam generator again. If the safety valves-107 continue to pop, close the water by-pass regulator shutoff valve-19 and manually regulate the trainline steam pressure by opening and adjusting the manual water by-pass valve-8.

REMOTE CONTROL EQUIPMENT

The remote control panel is located above the electrical cabinet on the rear cab partition, Fig. 9-4. Mounted on this panel are three switches: (a) a master switch to make the panel operative, (b) a push button switch to operate the separator blowdown valve-12, and (c) a push button switch to operate the remote control trainline shutoff valve-7. A trainline steam pressure gauge is mounted to the right of the remote control panel.

The remote control trainline shutoff valve-7 can be closed from the cab by depressing the button on the remote control panel; this will close the shutoff valves



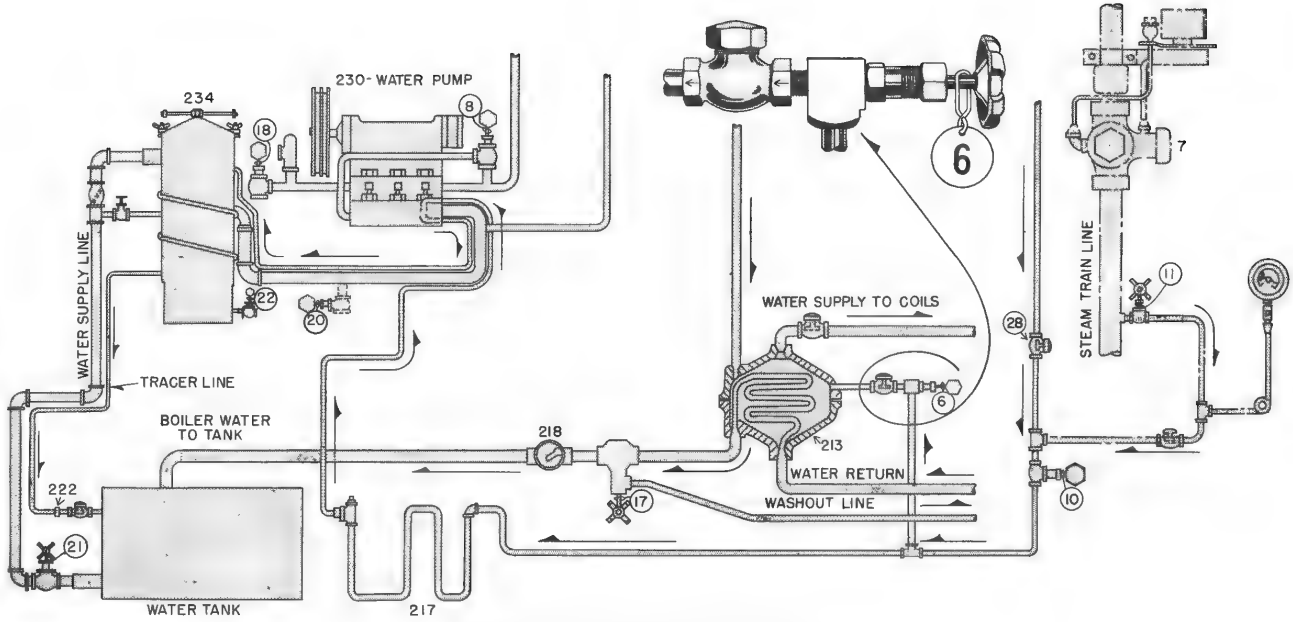
Remote Control Panel
Fig. 9-4

on all steam generators in the locomotive consist. The remote control trainline shutoff valve has to be opened manually by depressing the reset lever-7a, on the trainline shutoff valve-7, to the position marked "open."

Depressing the separator blowdown push button on the remote control panel will open the separator blowdown valves on all steam generators in the consist, for the length of time that the button is depressed.

ITEMS TO REPORT

1. Water pressure greater than 450 pounds at any time.
2. Excessive stack temperature.
3. Fluctuation of the fuel manifold pressure.
4. Frequent cycling of the burner.
5. Water flow indicator not cycling.
6. Water by-pass regulator inoperative.
7. Any faulty operation of the steam generator.



Protective Heating System
Fig. 9-5

STEAM GENERATOR OPERATION CHART
OK-4625

100. Atomizing Air Pressure Regulator
101. Atomizing Air Switch
102. Control Switch
103. Fuel Pressure Regulator
104. Fuel Solenoid Valve
105. Fuel Spray Head
106. Overload Reset Button, Motor
107. Safety Valves
108. Servo-Fuel Control and Switch
109. Stack Switch
110. Steam Temperature Limit Control
111. Water By-Pass Regulator and Switch
112. Water Pressure Relief Valve

200. Atomizing Air Strainer
201. Atomizing Air Pressure Gauge
202. Blower
203. Damper
204. Fuel Filter (Fuel pressure line)
205. Fuel Filter (Servo actuating line)
206. Fuel Filter (Suction line)
207. Fuel Nozzle Pressure Gauge
208. Fuel Pressure Gauge (At fuel pressure regulator)
209. Fuel Pump
210. Fuel Strainer
211. Fuel Tank
212. Generator Steam Pressure Gauge
213. Heat Exchanger
214. Ignition Transformer
215. Motor Converter
216. Oil Filler Cap
217. Radiation
218. Return Water Flow Indicator
219. Return Water Strainer
220. Spark Plugs
221. Steam Separator
222. Orifice Nipple (Radiation)
223. Steam Trap (Return water line)
224. Trainline Steam Pressure Gauge
225. Treatment Injector Filter
226. Treatment Injector Gauge
227. Washout Solution Inlet
228. Washout Solution Outlet
229. Water Pressure Gauge
230. Water Pump
231. Water Strainer Manifold
232. Water Tank
233. Water Treatment Injector Pump
234. Water Treatment Tank (Strainer tank only if injector system is used)

VALVES

Valves designated by odd numbers must be O P E N during normal operation of the steam generator. Valves designated by even numbers must be CLOSED during normal operation of the steam generator. Normally open valves are fitted with a cross type handle, normally closed valves are fitted with the standard round handle. These designations apply only to the OK series steam generators.

The following valves must be OPEN during normal operation of the steam generator:

1. Atomizing Air Shutoff Valve
3. Coil Shutoff Valve
7. Remote Control Trainline Shutoff Valve (If Used)
7a. Reset Lever (If Used)
9. Return Water Outlet Valve
11. Trainline Pressure Gauge And Cross-Over Valve
13. Steam Admission Valve to Water By-Pass Regulator
15. Trainline Stop (Shutoff) Valve
17. Three-Way Washout Valve
19. Water By-Pass Regulator Shutoff Valve
21. Water Supply Stop Valve

The following valves must be CLOSED during normal operation of the steam generator:

2. Coil Blowdown Valve and Switch
4. Fill-Test Valve
6. Layover Connection Shutoff Valve
8. Manual Water By-Pass Valve
10. Steam Admission Valve to Radiation (Open in cold weather)
12. Steam Separator Blowdown Valve
14. Washout Inlet Valve
16. Washout Inlet Valve
18. Water Pump Test Valve
20. Water Suction Line Drain Valve
22. Water Treatment Tank Drain Valve

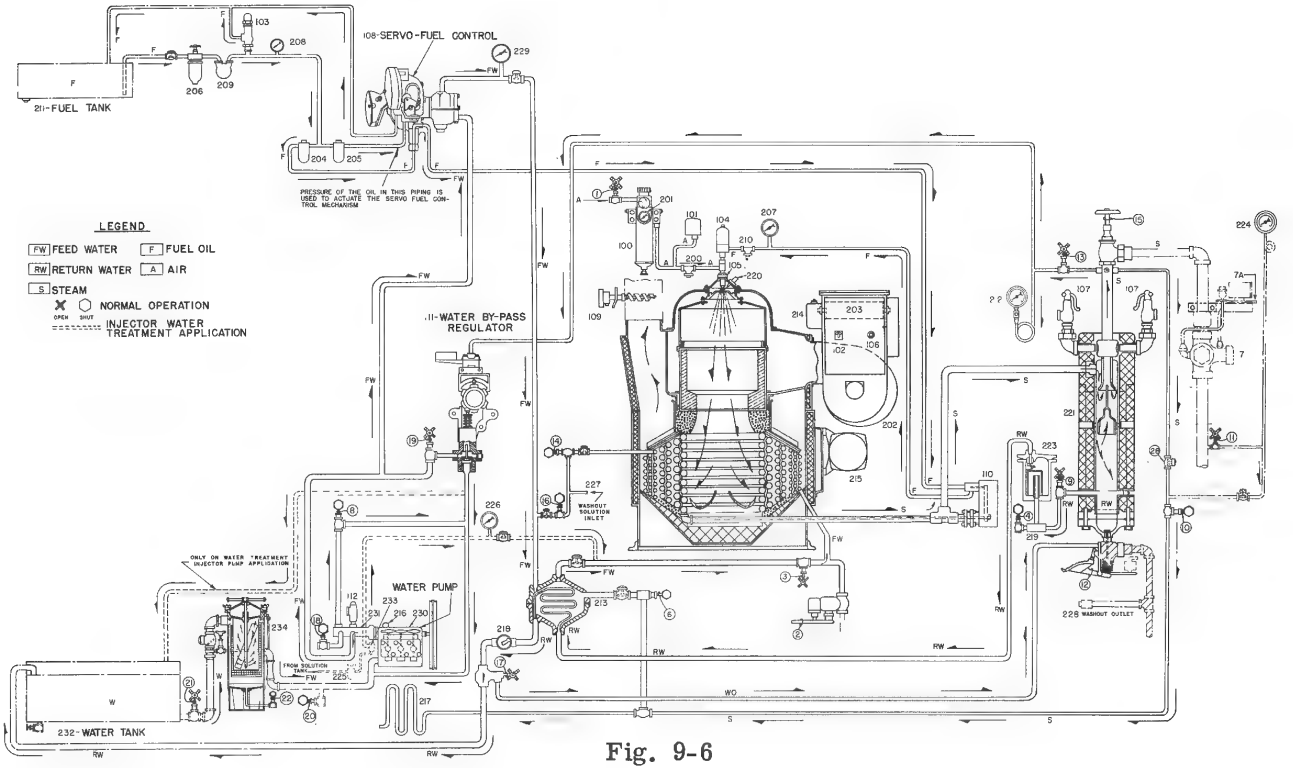

108-SERVO-FUEL CONTROL
211-FUEL TANK
PRESSURE OF THE OIL IN THIS PIPING IS USED TO ACTUATE THE SERVO FUEL CONTROL MECHANISM
LEGEND
FW FEED WATER
F FUEL OIL
RW RETURN WATER
A AIR
S STEAM
NORMAL OPERATION
INJECTOR WATER TREATMENT APPLICATION
111-WATER BY-PASS REGULATOR
WATER PUMP
ONLY ON WATER TREATMENT INJECTOR PUMP APPLICATION
FROM SOLUTION TANK
232-WATER TANK
WASHOUT SOLUTION INLET
228 WASHOUT OUTLET

Fig. 9-6

STEAM GENERATOR TROUBLE SHOOTING CHART

Symptoms	Cause of Trouble	Remedy
Panel lights do not light; bell does not ring (Control switch "OFF" Main boiler switch "ON")	Main battery switch "OPEN" Auxiliary generator switch "OPEN"	Close
	100 amp. boiler fuse (2) blown (distribution panel)	Test and replace
	15 amp. control fuse (2) blown (boiler panel)	Test and replace
Motor does not run (control switch "FILL," bell rings)	Stack switch tripped	Re-set
	Motor overload tripped	Re-set
	Coil blowdown valve "OPEN"	Close
Motor runs, no strong flow of water from water pump test valve	Water tank empty	Fill
	Valve on suction line closed (on line to treatment tank)	Open
	Drain valve on suction line or treatment tank open	Close
	Top of treatment tank not tight	Re-set and tighten
	Treatment tank strainer clogged	Clean
	Water in storage tank too hot	Make sure steam heat valve to water tank is closed

STEAM GENERATOR TROUBLE SHOOTING CHART (CONT'D)

Symptoms	Cause of Trouble	Remedy
Motor runs, no spark at electrodes	Wires from electrodes to transformer broken or grounding	Repair
	Terminals loose on transformer	Tighten
	Gap between electrodes too wide	Reduce gap (should be 3/16")
	10 amp. ignition fuse (2 on boiler panel) blown	Test and replace
Motor runs, fire does not light "Run"	Atomizing air valve closed	Open
	Motor not allowed to stop before turning switch to run	Turn "fill" briefly, then to "off." After motor has stopped and servo control is all the way down, turn to "Run."
	Electrodes not properly adjusted	Adjust. Report to maintenance.
	Nozzle not properly adjusted	Adjust. Report to maintenance.
Generator shuts off, bell rings	Stack switch tripped	Reset stack switch, refill coils, start steam generator, and set water by-pass regulator at slightly lower pressure. Report to maintenance.

STEAM GENERATOR TROUBLE SHOOTING CHART (CONT'D)

Symptoms	Cause of Trouble	Remedy
Generator shuts off, bell rings	Motor overload relay trips, shutting down generator	Reset overload relay, refill coils and start steam generator. Report to maintenance.
Generator runs, dome gets hot	Lack of air, dirty coils	Set water by-pass regulator back 10 to 15 lbs. Report to maintenance.
Generator runs but no water returns through water flow indicator	Valve in return line from separator closed	Open
	Return water strainer clogged	Clean
	Steam too dry	Report to maintenance
Generator runs but trainline pressure cannot be controlled by water by-pass regulator	Steam admission valve closed	Open
	Water admission valve closed	Open
	Defective water by-pass regulator	Close water shutoff valve to water by-pass regulator, use manual by-pass valve to control pressure. Report to maintenance.

SECTION 10

LOCOMOTIVE TROUBLE SHOOTING

1000 GENERAL The locomotive automatically protects its equipment in case of the faulty operation of most any component. There are two general ways that this protection is obtained: (1) by automatically reducing the engine speed to Idle, or (2) by automatically stopping the engine. A hot engine alarm might be considered to be the exception to the rule, since such an alarm does not change the engine load.

The general location of difficulty is indicated by the alarm bell ringing and the lighting of one or more alarm lights in the troubled unit. These lights are shown in Figs. 1 and 2, and are: hot engine—RED, low oil—YELLOW, boiler stopped—GREEN, alternator failure—PURPLE, ground relay—WHITE.

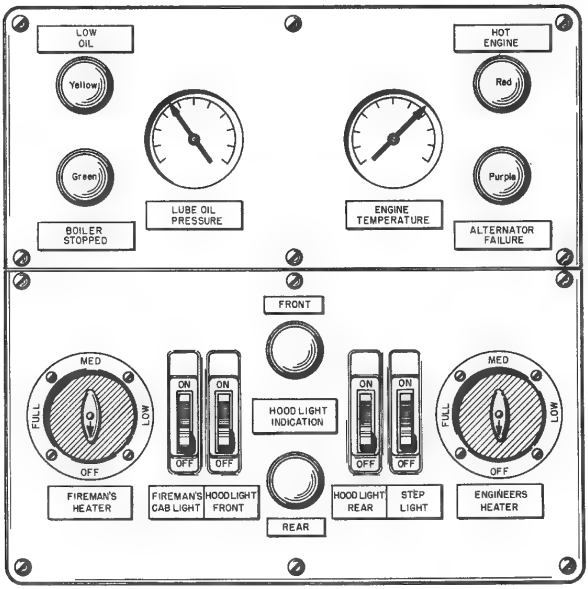


Fig. 10-1 - Instrument Panel

Fig. 10-2 - Control Panel

NOTE: a. All circuit breaker type switches on the above panel trip open at 15-amperes, except Control and Generator Field, which are 30-ampere circuit breakers.

b. The circuit breaker switches are ON (closed) when in the UP position; OFF - DOWN.

c. If a circuit breaker is overloaded and trips open, service is restored by first placing switch fully OFF and then moving it to ON.

1001 IF ALARM BELLS RING A signal light will be lit in the signal light bank on the front wall of the cab or on the control panel in the unit affected.

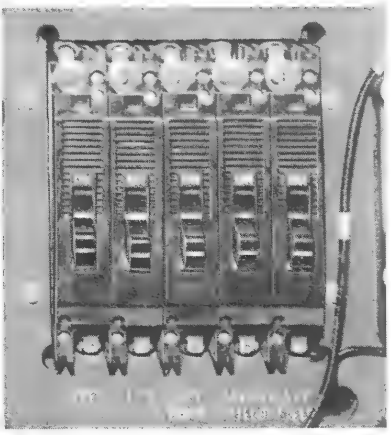


Fig. 10-3

RED — Indicates outlet engine water temperature over 208° F. Alarm does not cause a change in engine load or speed. Isolating engine does not extinguish alarm bell or light - alarm signal stops when temperature returns to normal.

See that cooling fan contactors are closed, shutters are open, and water level is correct. Fuel pump circuit breaker in electrical cabinet, Fig. 10-3, must be ON, or the cooling system fan and shutter control will be inoperative (fuel pump will also have stopped). If condition cannot be quickly corrected, isolate engine and investigate (allowing engine to Idle).

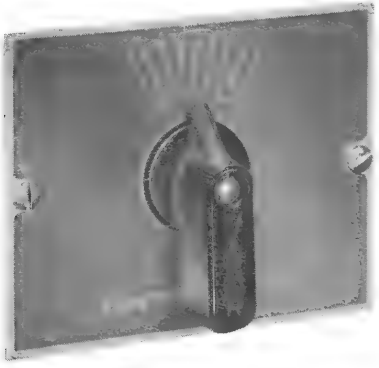


Fig. 10-4

GREEN — Indicates steam generator has stopped (if used). To extinguish alarm light and bell turn boiler control switch to OFF, Fig. 10-4. See Section 9 for steam generator trouble shooting.

PURPLE — Indicates alternator (AC) failure. Bell and light are energized when the NVR drops out, Fig. 10-6. This reduces engine speed and load to Run 1, or to STOP if the throttle is in Run 5 or 6. Placing the isolation switch in START (Fig. 10-5, engine isolated) stops the alarm signal.

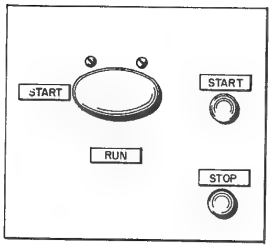


Fig. 10-5

Most AC failure alarms are "false" since this alarm occurs if the engine stops for any reason while "on the line." With an alternator failure alarm and the engine stopped, ALWAYS isolate and start engine before

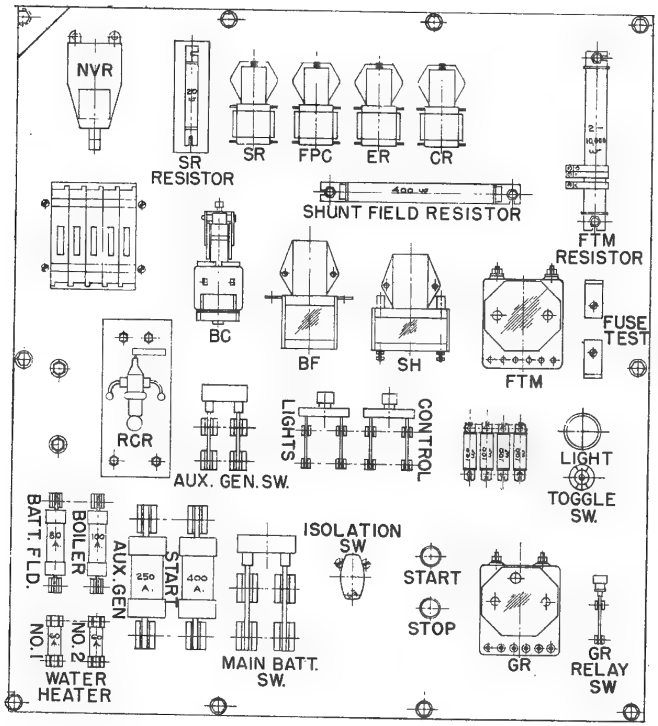


Fig. 10-6

worrying about the "failure;" check overspeed trip and fuel flow before trying to start engine. If other alarm indications are present with the AC alarm, they must also be checked.

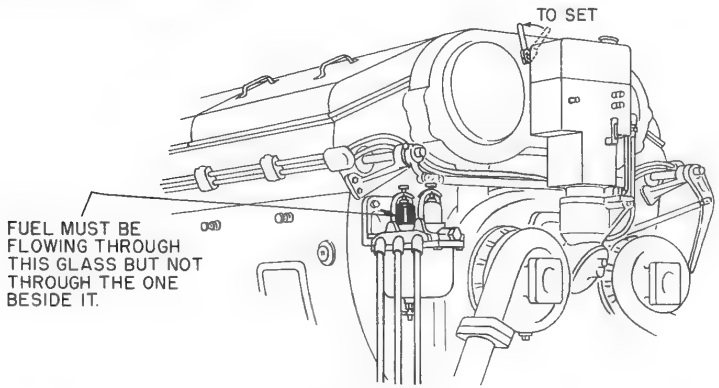


Fig. 10-7

A bona fide alternator failure is evident if the purple light and alarm bell are energized while the engine is running with the isolation switch in RUN ("on the line").

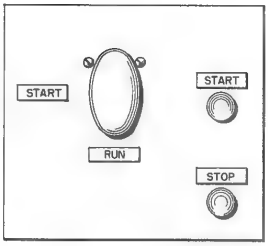


Fig. 10-8

With a true AC failure, check Auxiliary Generator Field and Alternator Field circuit breakers, these must be ON. If circuit breakers are OK, observe battery ammeter — a discharge indication means that Auxiliary Generator fuse is probably burnt out: Open Auxiliary Generator switch — remove fuse and check it — insert a good fuse and close Auxiliary Generator switch.

If the fuel pump circuit breaker on the control panel is OFF, or if the PC switch is open (tripped), the alternator failure alarm will not be able to indicate.

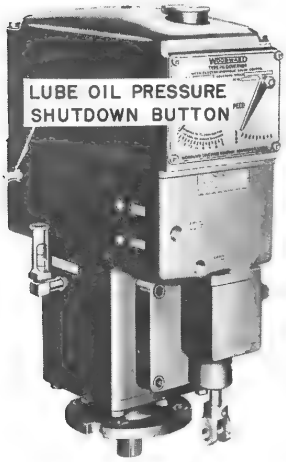


Fig. 10-9

Isolate engine and reset low oil trip button to stop alarm bell. Check oil level and condition, Fig. 10-10; if OK, start engine, check oil

YELLOW — Indicates low lube oil pressure or high lube oil pump suction. The tripping of the governor low oil alarm button, Fig. 10-9, always stops the engine and gives an alarm.

Fig. 10-10

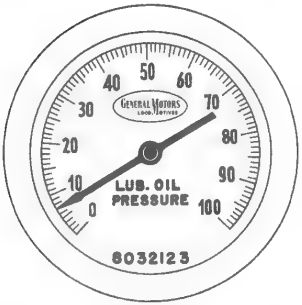


Fig. 10-11

pressure, Fig. 10-11, and place engine "on the line." Do not repeatedly start the engine if governor persists in shutting the engine down.

If a low oil alarm should stop the engine while "on the line," a purple light (Alternator Failure) can also be expected, since stopping the engine stops the generation of AC voltage.

WHITE — Ground relay light on engineman's control panel indicates a tripped GR, when lit, that has stopped power output in that unit and caused the engine speed to be reduced to Idle — or to Stop, if the throttle was in Run 5 or 6. If the ground relay trips, the indicating light and alarm bell will come on regardless of the isolation switch position.

To correct: isolate engine, reset ground relay, Fig. 10-12, and place engine "on the line." If ground relay continues to trip, reset to stop alarm, and leave the engine isolated. Check for a stuck starting contactor(s), Fig. 10-20, if ground relay should trip and refuse to be reset after starting engine.

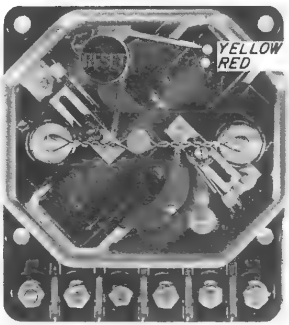


Fig. 10-12

1002 ENGINE GOES TO IDLE

a. Ground relay might be tripped.

b. No voltage relay might be opened.

c. PC switch might be tripped.

d. Control circuit breaker on the control panel mght be "Off."

e. Fuel pump circuit breaker on the control panel might be "Off."

1003 ENGINE STOPS

a. Throttle might be in STOP position.

b. Low oil pressure button on the governor might be out.

c. Engine overspeed device might have tripped.
d. No voltage relay might have opened with the throttle in RUN 5 or 6.
e. Ground relay might have tripped with the throttle in RUN 5 or 6.
f. Fuel pump circuit breaker on the control panel might have been tripped "Off," with the throttle in RUN 5 or 6.
g. PC switch might have tripped with the throttle in RUN 5 or 6.
h. Fuel pump circuit breaker in the distribution panel might be "Off."
i. Control circuit breaker on the control panel might be "Off."
j. Emergency fuel cut-off valve under the locomotive might be tripped, Fig. 10-23.

1004 HOW TO START THE ENGINE If the engine has been stopped for over 8 hours, the cylinders should be tested for fuel or water accumulation, see Article 1022. If stopped less than 8 hours, proceed as follows:

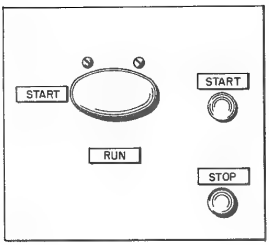


Fig. 10-13

a. Place isolation switch in START, Fig. 10-13.

b. Place throttle in Idle, and reverse lever in neutral position.

c. Place reverser drum in neutral position, Fig. 10-14.

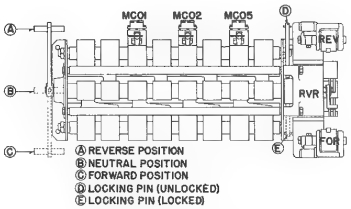


Fig. 10-14

d. Turn ON, or close, all switches and circuit breakers on the distribution panel.

e. At the control panel turn ON the Control and Fuel Pump circuit breakers.

f. After allowing a few seconds for fuel to flow through the return sight glass, solidly press in the START button and hold until the engine starts. If the engine fails to start after 15 seconds of rotation, check possible troubles listed under Article 1006 before again trying to start engine.

g. After allowing time for the lube oil pressure to build up, place isolation switch in the RUN position.

1005 THE ENGINE DOES NOT ROTATE WHEN "START" BUTTON IS PRESSED

a. Control circuit breaker on the control panel panel must be ON.

b. Isolation switch must be in the START position.

c. 400-ampere starting fuse must be good.

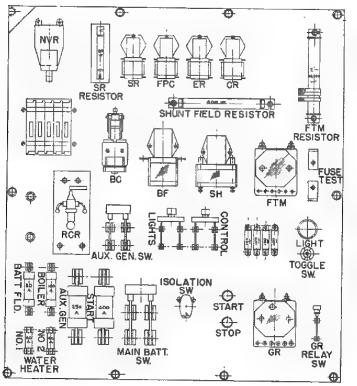


Fig. 10-15

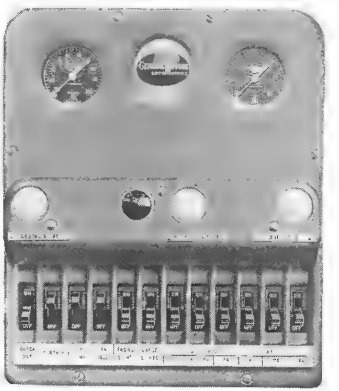


Fig. 10-16

d. Main battery switch must be closed.

e. Control switch on the distribution panel must be closed.

1006 THE ENGINE ROTATES BUT DOES NOT START WHEN "START" BUTTON IS PRESSED

a. Fuel pump circuit breaker on the control panel must be ON.

b. Low oil pressure button on the governor must be pressed "in."

c. Engine overspeed trip must be "set."

d. Fuel pump circuit breaker on the distribution panel must be ON.

e. Emergency fuel cut-off valve must not be tripped.

f. The PC switch must not be tripped.

1007 THE ENGINE DOES NOT SPEED UP WHEN THROTTLE IS OPENED

a. Control circuit breaker on the control panel must be ON.

b. Isolation switch must be in RUN position.

c. PC switch must not be tripped.

d. Ground relay must not be tripped.

e. No voltage relay must not be opened.

f. Control switch in electrical control cabinet must be closed.

g. Fuel pump circuit breaker on the control panel must be ON.

1008 ENGINE SPEED PICKS UP BUT LOCOMOTIVE DOES NOT MOVE WHEN THROTTLE IS OPENED

a. Reverse lever must be in either reverse or forward position.
b. Generator field circuit breaker must be ON.
c. There must be 90 pounds control air pressure.
d. Starting contactors must not be stuck.
e. All brakes, hand and air must be released.
f. 80-ampere battery field fuse must be good.

1009 BATTERY AMMETER SHOWS CONTINUAL DISCHARGE

a. Battery charging contactor located above the Aux. Gen. switch must be closed.

b. 150 or 250-ampere battery charging (auxiliary generator) fuse, to left of isolation switch, must be good.

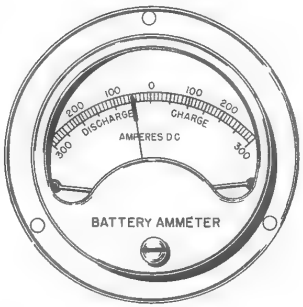


Fig. 10-17

c. The auxiliary generator field circuit breaker in the electrical control cabinet must be ON.

d. The auxiliary generator cutout switch in the electrical control cabinet must be closed.

1010 LOCOMOTIVE FAILS TO MAKE FORWARD TRANSITION

See that the transition forestalling switch, located on the controller is in the UP-AUTOMATIC position, Fig. 3-5.

1011 PC SWITCH The pneumatic control switch, often called the "power cutoff" switch, is an air operated electric switch that is tripped open by any "penalty" or emergency air brake application. When open, this switch automatically shuts off the fuel pump and reduces the power output of the engine to Run 1 or to Stop if the throttle is left in Run 5 or 6). A white indicating light on the control panel will be be lit whenever switch is tripped open. The tripping of the PC switch does not, in itself, ring the alarm bell. However, if the engine is caused to stop, the purple light and alarm bell will come on when the PC switch is reset.

The PC switch is automatically reset provided that (1) the throttle is returned to Idle, and (2) control of the brake is recovered. To reset:

a. Close throttle to IDLE.

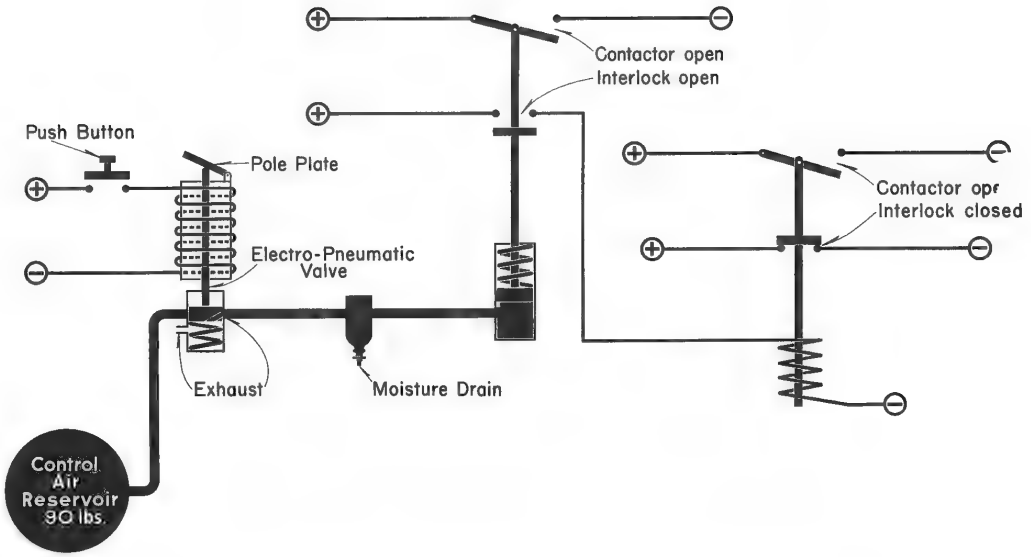
b. Place automatic brake valve in LAP.

c. Place foot on safety control foot pedal.

d. Wait until application pipe builds up to normal pressure; listen for exhaust or watch PC switch light. If, after an emergency application, the PC switch does not reset itself with the automatic brake in LAP, move the brake valve to RUNNING.

e. Place automatic brake valve in RUNNING.

The reason for not completely shutting off the power output of the engine with PC action is to allow the possibility of "plugging" the motors (i.e. reversing them to the direction in which they are moving) in an EXTREME EMERGENCY where the air brakes fail to operate for some cause. However, THE MOTORS MUST NEVER BE PLUGGED EXCEPT IN A DIRE EMERGENCY, as this practice can severely damage



Basic Electro-Pneumatic And Electro-Magnetic
Contactors And Interlocks
Fig. 10-18

the electrical equipment. Plugging the motors can be accomplished by closing the throttle to Idle and moving the reverse lever to the opposite direction (for additional braking the throttle may be opened to Run 1); the controls, to this extent, will operate even though the PC switch may be open.

1012 GROUND RELAY

If ground relay trips, a white indicating light on the control panel will light, the alarm bell will ring and the engine will go to idle (if throttle is in Run 5 or 6, engine will stop). To reset relay, place throttle in Idle, isolate engine, and press the reset button; this moves the relay pointer from the red dot (tripped) to the yellow dot (set).

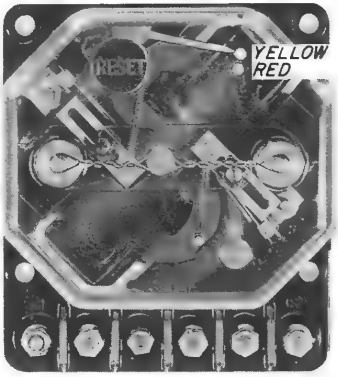
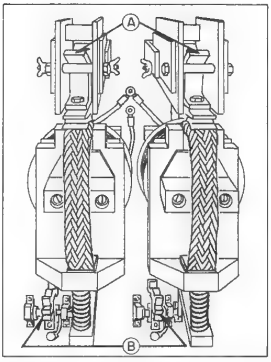


Fig. 10-19



Ⓐ MAIN CONTACTS SHOULD BE OPEN
Ⓑ INTERLOCKS SHOULD BE CLOSED

Fig. 10-20

1013 STARTING CONTACTORS

Starting contactors will sometimes weld together when an engine is started, especially if the START button is not held in firmly. If a starting contactor welds closed, the unit will not deliver power even though the engine will speed up. The contacts may be separated by prying the contacts apart with a piece of wood or other non-conductive material. When the starting contacts are open the interlocks are closed, and vice versa.

1014 ENGINE OVERSPEED TRIP If the engine speed should exceed approximately 910 RPM, an overspeed device located on the front end of the engine will trip and stop the engine by preventing the injectors from injecting fuel into the cylinders. The alarm bell and purple light will come on if the engine is stopped in this manner while "on the line." The overspeed trip must be latched in the Set position before the engine can be restarted.

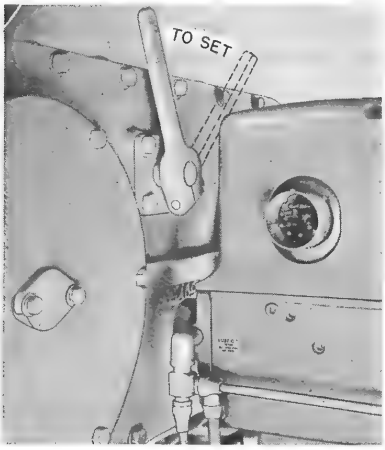


Fig. 10-21

1015 LUBE OIL PUSH BUTTON ON GOVERNOR In case of low oil pressure or high suction the governor will stop the engine and cause the alarm bell and yellow light to come on. A push-button on the front of the governor will move out exposing a red band on the button shaft. To reset, push the button back into the governor housing and start the engine in the usual manner.

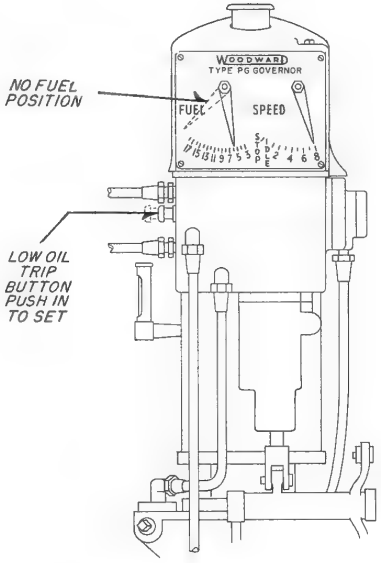


Fig. 10-22

1016 FUEL CUTOFF VALVES If these valves are tripped, accidentally or by pulling an emergency pull cord, the fuel supply will be stopped. The emergency fuel cutoff valves are located inside the engine-room hood, near the right rear end of the engine, just below the level of the catwalk. To reset: pull each valve stem up so that the yoke, which normally holds the valve open (valve stem up), may be slid into place, Fig. 10-23.

Fig. 10-23

1017 FUEL FLOW For proper operation, a good flow of fuel (clear and free of air bubbles) should be indicated on the fuel return sight glass, on duplex filter assembly nearest engine, Fig. 10-24.

If the fuel is not flowing through the return sight glass, check the fuel pump motor. If the motor is stopped, check PC switch, circuit breakers and the switches on control and distribution panels; also cable connection to motor. If pump is running but fuel is not pumped, check fuel supply, emergency fuel cutoff valve, a suction leak in piping, or a slipping coupling at fuel pump.

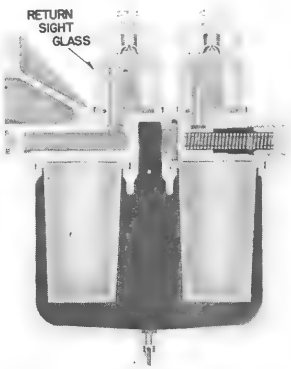


Fig. 10-24

1018 ENGINE SPEED AND FUEL INDICATORS There are two pointers on the cover of the governor, Fig. 10-22. One pointer indicates the engine throttle position (SPEED). The second pointer indicates the power piston position in 16ths of an inch (FUEL). The lower the number on the fuel scale, the greater is the quantity of fuel being used by the engine. In SPEED 8, the FUEL pointer should indicate between 5 and 6, if the engine is loading properly. If a marked variation is noted, the trouble should be investigated.

Fig. 10-25

1019 CONTROL AIR PRESSURE For satisfactory operation, the electrical control air pressure gauge on the rear wall of the cab must indicate 90 lbs. The pressure regulator, Fig. 10-25, is located in the electrical cabinet. To raise or lower the pressure, adjust the knob on top of the regulator. A drain cock is provided on the bottom of the regulator for draining moisture.

1020 COMPRESSOR CONTROL The air compressor is automatically governed and will normally keep the main reservoir pressure at 130-140 p.s.i. In an emergency, the normal position of either of the valves, may be changed as shown in Fig. 10-26 to manually load or unload the air compressor.

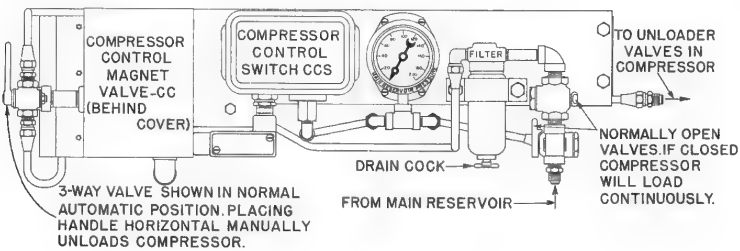


Fig. 10-26

1021 CYLINDER TEST VALVES Each cylinder is equipped with a test valve, Fig. 10-27, for the purpose of testing for fuel or water accumulation in the cylinders prior to starting an engine that has been shut down for over 8 hours.

To make this test, remove the 400-ampere starting fuse, open all cylinder test valves approximately 3 full turns, and use the engine jacking tool to rotate the engine one complete revolution. If liquid is discharged from any cylinder, investigate; if not, close cylinder test valves, replace 400-ampere starting fuse, and start engine in the usual manner.

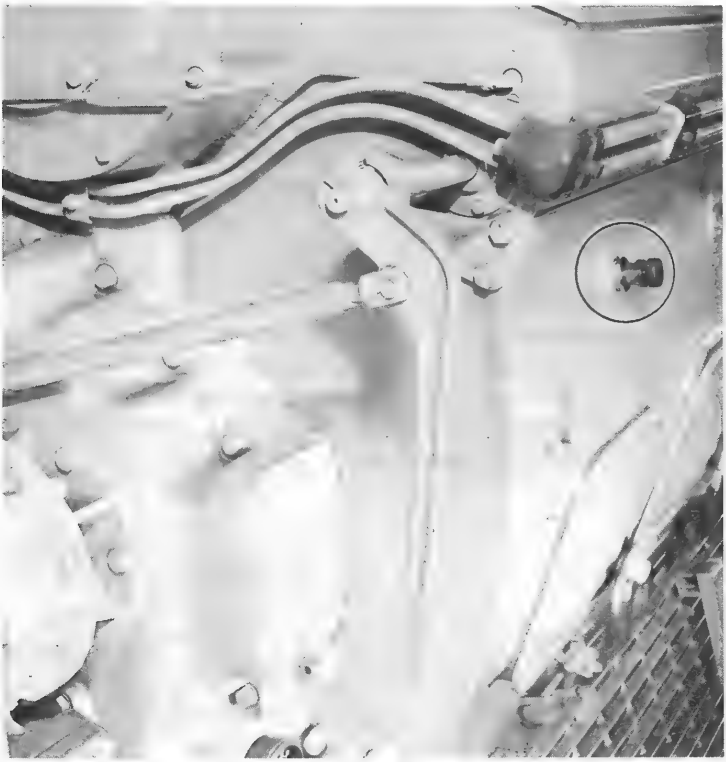


Fig. 10-27

If the engine is running and any cylinder test valve is heard to be leaking, the engine should be stopped, and the valve(s) should be tightened.

1022 TYING UP THE LOCOMOTIVE

a. Place isolation switch in START.

b. Press STOP button in and hold until engine stops.

c. Put all the circuit breakers at the engineman's control panel in the OFF position (down).

d. Remove reverse lever from controller.

e. Open main battery switch.

f. Set the hand brake mounted on the front platform of the locomotive. This brake is effective on but one pair of wheels. The brake is applied by turning the hand wheel clockwise as far as it will go. The brake is released by turning handwheel counter-clockwise against the friction locks. Always release brake before moving locomotive.

g. Take precautions against freezing in cold weather.

h. If the locomotive is to be left standing outside, cover the exhaust stacks if there is danger of a severe rain.

Fig. 10-28

NOTES

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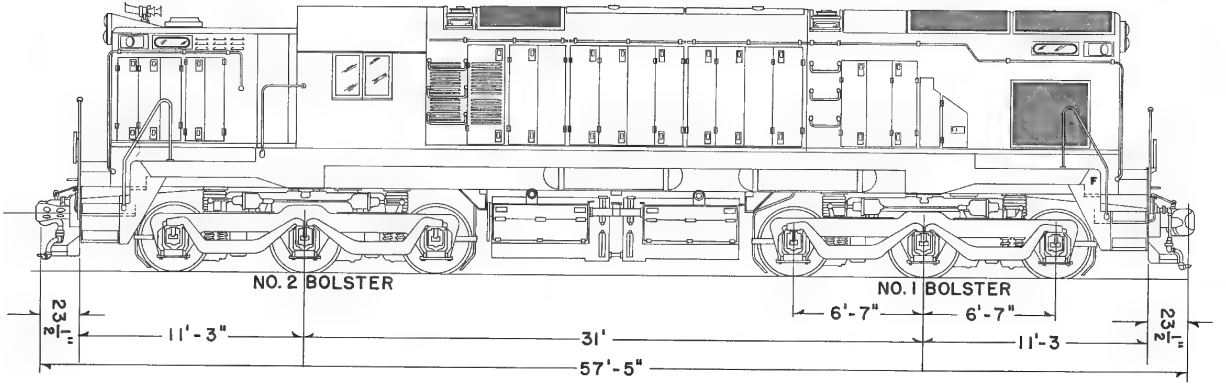
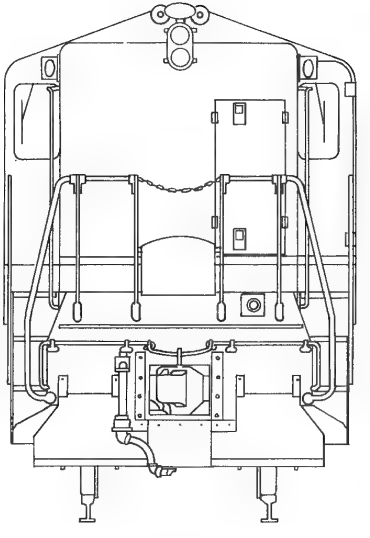
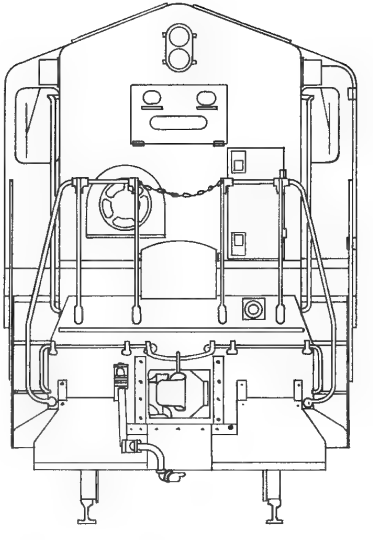
APPENDIX



MRS-1 Locomotive Outline
Chart I (Part A)



REAR VIEW



FRONT VIEW

Chart I (Part B)

LEGEND OF ELECTRICAL EQUIPMENT
Chart 2

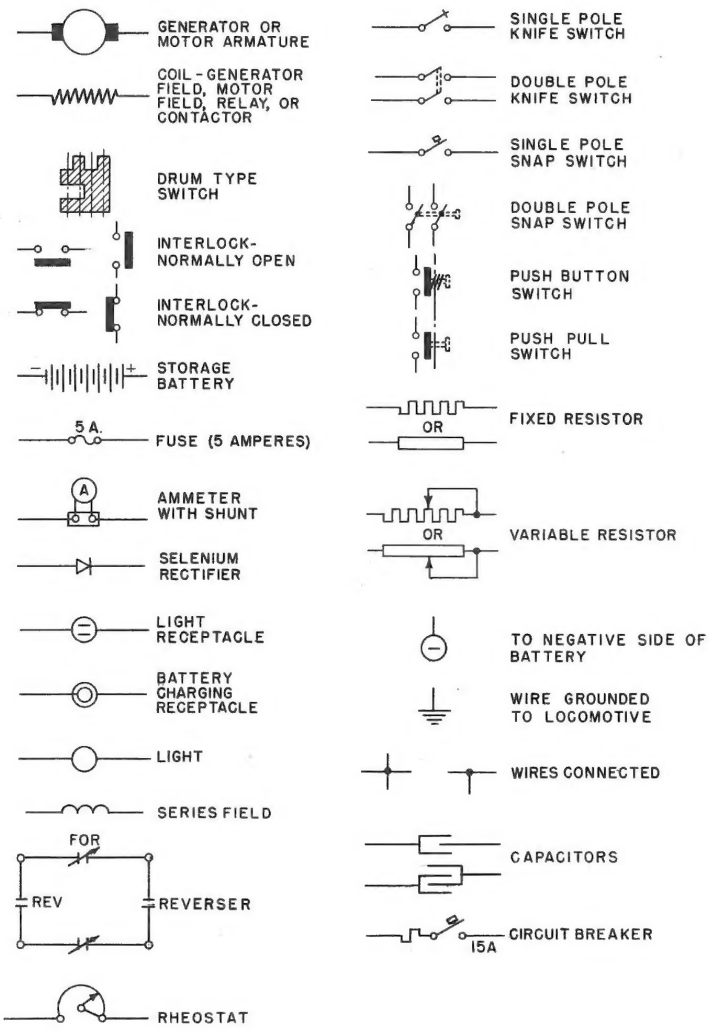
The following is a list of abbreviations used to identify electrical equipment on schematic wiring diagrams. The diagram wire designations conform with the identification bands on the wires in the locomotive.

The wiring diagram, Chart 4, shows the contactors, switches and relays on a MRS unit with the engine stopped and all manual switches open. It must be remembered that when the operating coil of a contactor becomes energized, the contacts and interlocks associated with that contactor will then be in a position opposite to that shown in the wiring diagram.

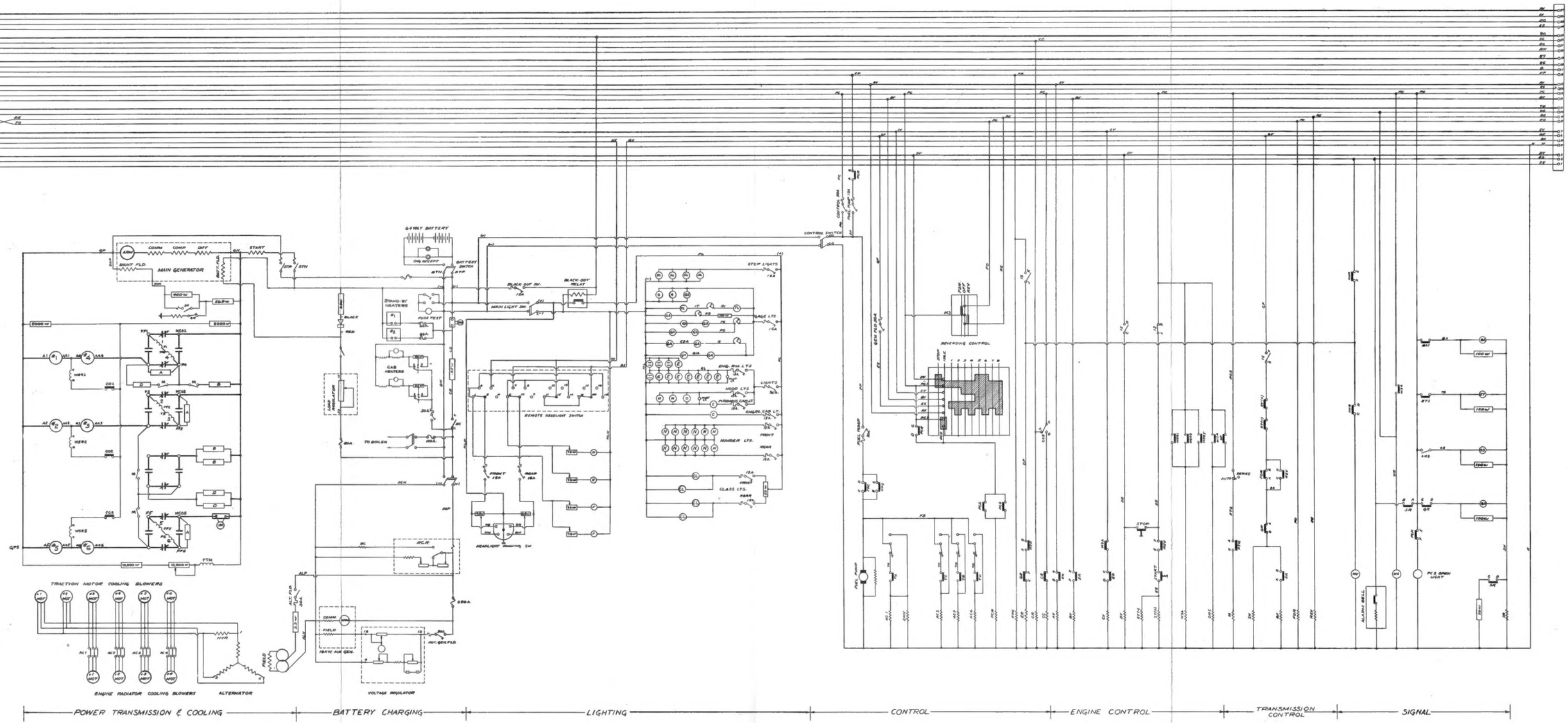
A, AA	Traction Motor Armature Connection
AC1, 2, 3 & 4	Cooling Fan Motor Contactors
AM	Battery Ammeter
AV, BV, CV, DV	Governor Control Solenoids
BA	Boiler Alarm Light
BAS	Boiler Alarm Switch
BC	Battery Charging Contactor
BF	Battery Field Contactor
C	Cab Light
CC	Compressor Control Magnet Valve
CCS	Compressor Control Switch
CL	Classification Light
CO1, 2, 5	Motor Cut-out Interlocks
COMM	Commutating Field
COMP	Compensating Field
CR	Compressor Control Relay
DIFF	Differential Field
E	Engine Room Light
ER	Engine Relay
ET	Engine Temperature Alarm Light
ETS	Engine High Temperature Switch

LEGEND OF ELECTRICAL EQUIPMENT (Cont'd)

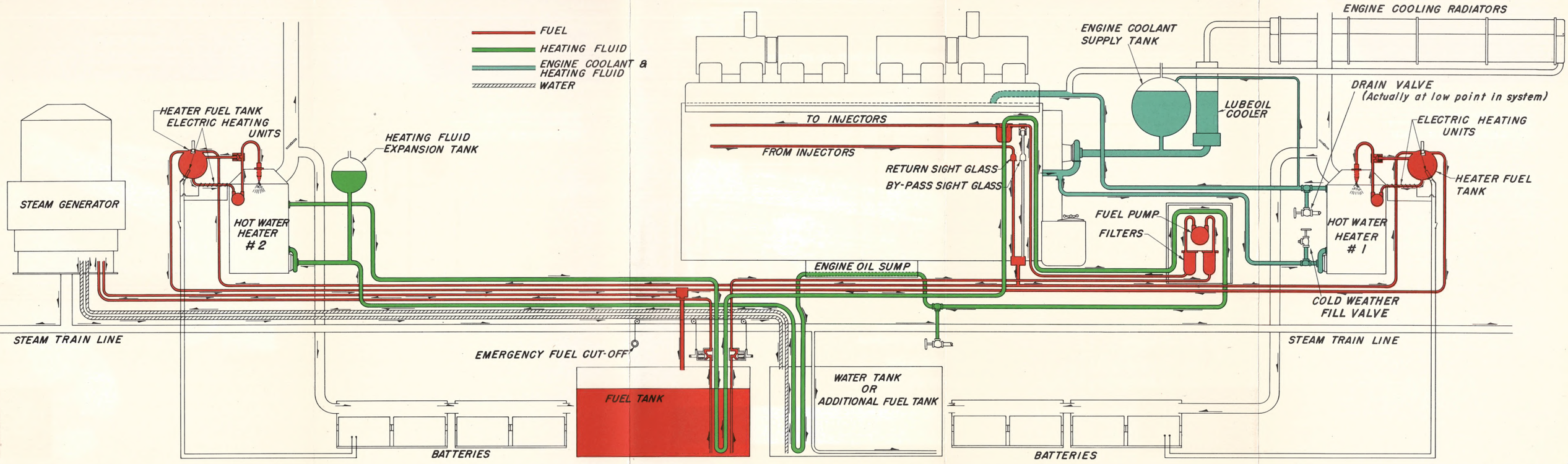
F, FF	Traction Motor Field Connection
FOR	Reverser Magnet Valve - Forward
FPC	Fuel Pump Contactor
FTM	Forward Transition Motor Shunting Relay
G	Ground Light
GA	Gauge Light
GR	Ground Protective Relay
H	Hood Light
IM	Load Indicating Meter
IS	Isolation Switch
LOS	Lube Oil Alarm Switch
M	Motor Shunting Contactor
MCO1, 2, 5	Motor Cut-out Switches
N	Number Light
NV	"Alternator Failure" Signal Light
NVR	No AC Voltage Relay
ORS	Overriding Solenoid (In Governor)
PCR	Pneumatic Control Relay
PCS	Pneumatic Control Switch
RCR	Reverse Current Relay
REV	Reverser Magnet Valve - Reverse
SH	Shunt Field Contactor
SL	Step Light
SMV	Shutter Magnet Valve
SR	Alarm Signal Relay
ST+, ST-	Starting Contactors
START	Starting Field
TA, TB, TC, TD	Temperature Control Switches
WS	Wheel Slip Indicator Light
WSA	Wheel Slip Auxiliary Relay
WSR1, 2, 5	Wheel Slip Relays



Electrical Symbols - Chart 3



Basic Schematic Wiring Diagram - Model MRS-1 (Chart 4)



Winterization System Schematic
CHART 5